Pit and Quarry

SAND-GRAVEL-STONE CEMENT-LIME-GYPSUM

Vol. XII, No. 7. JULY 7, 1926 Circulation 7,200

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Pit and Quarry

A Semi-Monthly Publication for Producers and Manufacturers of Sand, Gravel, Stone, Cement, Gypsum, Lime and Other Non-Metallic Minerals.

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Vol. 12 CHICAGO, ILL., JULY 7, 1926 No. 7

FEATURE CONTENTS

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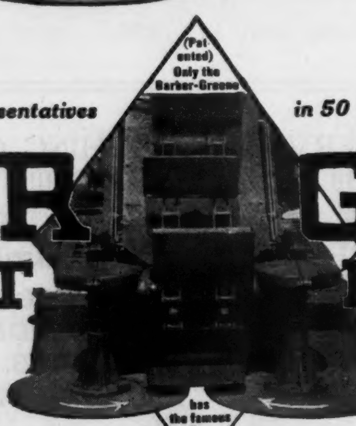


BARBER GREENE
BUCKET LOADERS

Pit and Quarry

Vol. 12 CHICAGO, ILL., JULY 7, 1926 No. 7

CONSERVING ENERGY

EXECUTIVES are often far sighted in prolonging the life of machinery and blind in conserving the energy of themselves and of their men. They have spent large sums of money on the machinery, and consequently they wish to make it last as long as possible. They will listen eagerly to suggestions regarding the various methods of getting the best results and longest service from a steam shovel or a crusher. They provide for repairs, they instruct employees in the care of equipment and they plan for rest periods for machinery in order to extend the time of its usefulness. And they are justified in dealing with machinery intelligently and scientifically. The most elementary principle of economy is a basis for such procedure. The fact that they sometimes fail to apply the same theory to themselves and to their men is a weakness in their business psychology. The executive who evaluates the human machine accurately is the one whose business expands and whose profits increase.

In any occupation, from that of chief executive to that of untrained helper, the key to fitness for work is the mental attitude of the individual. If he has a healthy, wholesome conception of his job, he will attain satisfactory results. On the other hand, if his mental attitude is wrong, he is ineffectual in everything he attempts to do. The executive who can lead without "bossing," who retains the respect and confidence of his men, who believes in himself and in his men, is the one who sees his position in the right perspective. Such an executive lightens his own load because he has the proper mental attitude toward his job. There are certain qualities of leadership which pertain to his work. Although he knows more than anyone else about the aims and working policies of the organization, he will secure the services of experts whose technical skill is greater than his own. He will delegate authority to capable men and in no case attempt to carry the load of management himself. His time may well be spent in surveying the present situation and in planning for the future. If he does not expend his energy in daily routine which could be carried by subordinates, he has energy for the important task of preparing for the years ahead. This type of executive is respected by his men and admired by his competitors.

In the same way the employee who has a sane outlook on his work can do that work with a minimum expenditure of energy. He has been thoroughly trained for the task; he believes that the job is worth while; he has reason to respect and like his superiors in the organization; and consequently he is of maximum value to his employer. The employee who conserves his energy does not loaf on the job. Steady consistent work is less wearisome than slovenly effort. Habits of carelessness and laziness are conducive to fatigue. Brisk, intelligent work is normal and satisfying. Hence, the men who are trained to work without undue loss of energy are worth more to themselves and to their employers than are those who waste time and strength. The executive will find it of practical value to study the various ways of making the best use of the forces which make his business possible and profitable.

Unquestionably, the most apparent element in an analysis of fitness for work is health. No task can be performed satisfactorily by a man who is sick. It is, therefore, the duty of the executive to provide all means possible for maintaining good health for himself and for his men. There are well known common-sense rules about health which are assumed to be understood by everyone. There are the ordinary rules governing eating, sleeping, moderation in all aspects of life, exercise, and proper care in case of illness. A little attention to conditions affecting the health of the members of an organization will be of value in this matter of conservation of energy. The relative values of men who are healthy and those who are not are too obvious to merit comment. Some of the causes of physical unfitness are not always understood, however. Fatigue beyond a certain point, worry, discontent, anger, and unrest are often the remote causes for illnesses which are diagnosed as acute indigestion or some ailment which is more easily prescribed for than the real trouble. Sanitary physical conditions and sanitary mental conditions about a plant are of equal importance in the problem of health. A good spirit throughout the organization may be one factor which prevents loss of time and excessive labor turnover.

That indefinable spirit within an organization which we call morale or esprit de corps is an important factor in this problem of keeping fit. The emotions listed above, which may be the cause for real illness, may also be the basis for other deterring elements in the effort to conserve energy. On the other hand enthusiasm and loyalty are tonics with far reaching effects. A man who is a human dynamo may be of little value to the organization, while one who is below normal physically may be a large contributor to the day's output. The spirit of the group with its inevitable effect on the spirit of the individual is the key to increase in production and to the condition of the members of the organization. If a unit of the business fails to get results, there is probably a cause which can be ascertained. There may be friction among the members which can be eliminated by careful organization, proper supervision, effective discipline and wise readjustments which will restore a spirit of cooperation and goodwill to the workers. There must be team work if objectives are to be attained without undue loss of energy. It is as necessary that the working group functions harmoniously as that a machine run smoothly. The machine may need oil or overhauling; the personnel of the group may need reorganization.

Machinery costs money and must be handled carefully. The executive also costs money. He has spent years in preparation for the position which he occupies. A life of hard work has in most instances preceded the success which he now enjoys. He will tell you with a gleam of pride in his eyes how much hard work he has done, what strenuous efforts were made in building up his organization. He may well take as good care of himself as he does of a machine which represents a small output in comparison with his labor. The workmen cost money. Every man's value increases in proportion to the length of time he stays. If he makes a mistake, he has learned not to repeat the error. It is a blind executive who discharges a man because he makes a mistake. It is true that the loss to the company is often great, but it is also true that the man has learned a valuable lesson. Better that he learn the lesson without the loss, but better also that the value of the lesson revert to the company. If he is sent elsewhere, some other company takes on a workman who knows, at least, not to make that mistake again.

ADJUSTING A FIRE INSURANCE LOSS

THE time to adjust a fire insurance loss is before the fire happens. This statement sounds absurd; yet it is actually possible by maintaining an intelligent appraisal and having the insurance policies written according to what the appraisal shows. The hardest part of adjusting a loss, whether the loss is caused by fire, tornado, flood, earthquake, or any other insurable accident, is to get the property owner to tell what his loss really is. The evidence, if the loss was by fire, has been burned up. The real extent of the loss cannot be proved. Many producers have such inadequate records that they could not state under oath just how much their physical equipment is worth. Much of the apparent objection of insurance adjusters to loss claims is not due to a difference of opinion or to an attempt to minimize the loss, but is simply due to the policy holder's inability to establish his loss intelligently.

An appraisal is a valuable step in putting insurance on a sound basis. It shows what property is really worth. It is not just the opinion of an expert, which might be disputed by any other expert. It is an actual inventory of the lumber, bricks and metal making up a given plant, and a translation of the value of these materials into dollars. While the opinion of an expert cannot be verified after the property has been destroyed, it is hard for an insurance adjuster to dispute a reliable appraisal.

The basis of insurance is the actual value of the property to be insured. This actual value does not mean the original cost, for changes in market or building prices may make it worth more or less than when it was new. Nor does actual value mean reproduction cost, for reproduction would imply the reproduction of a new building or machine, while the property itself has depreciated and is actually worth somewhat less than new equipment of the same sort. And finally, actual value does not mean book value, although many firms base their insurance on their book value and think they are safely protected. Book values are really fictions that are created by accountants in order to make a favorable showing to stockholders or for tax purposes. They usually ignore increases in building or market costs; their rate of depreciation is arbitrary and often excessive, or the property may have been enlarged or rebuilt in such a way as to lose correct record of the original investment.

Actual value of property means its present cost, new, at current market prices, minus actual depreciation. The item of cost includes not only the stated price of certain materials or machines, but also the costs of transporting them to the insured plant and of labor for installation. Depreciation may come from wear and tear, age, inadequacy or obsolescence. If the producer will figure his reproduction costs and depreciation accurately before buying his insurance, he will be reasonably sure of a satisfactory loss adjustment and he will also be sure that he is not carrying more insurance than he needs.

ANNOUNCEMENT EXTRAORDINARY!

WITH this new issue, which you now hold in your hands, PIT and QUARRY reaches a new mile post in it's ten-year record of unparalleled achievement.

Nothing would have pleased us more than to have been able to walk into your office personally and to have placed this issue in your hands.

We are naturally proud of the growth of PIT and QUARRY, and we are sure also that our readers share in this feeling.

Together we have seen this magazine grow from the first small begining of ten years ago, when it was issued only once every two months, soon to a monthly, then to twice a month, and now to its present large size and form issued every other Wednesday.

During all these years PIT and QUARRY has set the pace in its field and held leadership, because it knew best how to serve its readers and to give them the facts they want and need.

But the past, rosy as it has been, is only the beginning. Looking ahead we see still greater and better things—things in which we know you will be glad to have a share.

IT IS only because of the good will and co-operation of its readers that PIT and QUARRY has been able to reach this high pinnacle it holds today and because of its new and larger form we are confident it will be capable of even greater service.

An expression from you on the "new" PIT and QUARRY would be greatly appreciated.

Have you been saving your issues of PIT and QUARRY? The ten large yearly volumes already published make a veritable library of facts and suggestions for every executive in the field of the non-metallic mineral industries. And yet, all this great collection of facts, figures, records, and experiences of firms in the field, is but a symbol, an evidence or proof of what PIT and QUARRY can mean to you in the months and years to come.

As you read this new issue you hold, we want you particularly to note, first, the large, clear type used. This will make reading both easy and a pleasure. Second, we want you to notice the two-column arrangement throughout most of the book. Third, we want you to observe the high quality of the illustrations made possible by the finer, heavier grade of paper stock in the magazine.

Finally, we want to emphasize the timeliness and the extreme range of news and editorial. Every issue of PIT and QUARRY is intended to bring to its readers—and it does, if we may judge from the many commendations received—news, facts, and ideas that are not only interesting, but that have a very definite dollars and cents value to them.

IN NO figurative sense, PIT and QUARRY serves as a great clearing house for ideas between the progressive executives in the field of the non-metallic mineral industries. By reading its pages you are kept constantly in touch with all new developments and with the best brains in the field.

PIT and QUARRY stands out as the leader in its field because it does the things leadership demands.

Stop and ask yourself what it is you most want and need to know to make your business grow and to insure better profits. You have, first of all, your problems of organization, production, and management. But you have also to deal with such questions as workmen's compensation, business losses, profit sharing, employes' welfare, insurance, and the like.

We mention also income taxes, night operations, prime movers, compressed air and air compressors, coal specifications—the list is almost unending.

Only PIT and QUARRY has dealt wtih these subjects, only PIT and QUARRY, because it has stayed closer to its readers. Because it has worked in the field with those it seeks to serve, it has been able to win the high approval and lasting good will which is so much appreciated by the publishers.

That in fact is the major burden of our message. We want you to know that your good will and co-operation is appreciated, and we look forward confidently to even closer relationship and greater service both to the industry and to you.

TRAP ROCK PRODUCTION ON A LARGE SCALE

THE NEW HAVEN TRAP ROCK COMPANY KNOWS HOW

By F. A. Westbrook

THE New Haven Trap Rock Company at North Branford, Connecticut, has what is said to be the largest genuine trap rock operation east of the Rocky Mountains. This rock is of a very fine grained type which has a crushing strength of 49,500 pounds per square inch. The production is about 80,000 yards per month, and the plant is so well managed and is so well equipped with machinery that this is accomplished with only 130 men including the office and dock employees.

This operation is of unusual interest both from the standpoint of the completeness of the labor saving machinery which has been installed and on account of the facilities which have been developed for shipping by rail and water.

The property covers more than 100 acres located on a ridge of trap rock about 500 feet high which extends east and west approximately paralleling the Connecticut shore of Long Island Sound and extending back about five and a half miles. The crushing plant is located well up the slope of the ridge so that it has been possible to make use of gravity to a considerable extent in progressing from one process to the next.

Before discussing the crushing plant it will be well to give rather detailed consideration to the quarry. It is at present being worked on two benches each about fifty feet high.

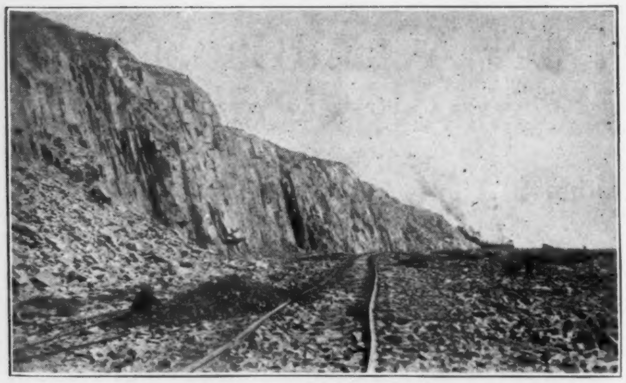
The drilling is done vertically from the top and horizontally from below. Mr. Alexander McKernan is superintendent of this plant. The vertical drilling is done by four Keystone drills. The line of holes is located thirty feet back from the edge, and they are made twenty feet apart. They are drilled to only about two-thirds of the height of the bench. The horizontal drill holes extend in the full thirty feet and are eight feet apart. Ingersoll-Rand Legner X70 drifter drills are used for this purpose and are shown in one of the illustrations. They are capable of drilling 125-150 feet per day in the very hard rock found in this quarry. By shooting both sets of holes simultaneously the tough trap rock is well broken up and a good level floor is maintained in the quarry. Sixty per cent gelatin dynamite, Dupont and Hercules, is used for blasting.

Mr. McKernan has contrived, with true Yankee ingenuity, a convenient arrangement for sharpening the drills, which in reality is nothing more than a box car fitted up with an Angersoll-Rand oil furnace and an Ingersoll-Rand drill sharpening machine. The car is hauled to a point in the quarry as close as possible to where the drilling is under way and left on an unused track. Of course compressed air must of necessity be available for the Leyner drifter drills, and it is an easy matter to tap their supply line for the benefit of the furnaces and drill sharpener. It is not hard to realize what a great convenience and labor saver the traveling shop is. It saves all the labor of loading and unloading the long heavy drills on cars; it avoids all interference with the use of the quarry transportation equipment for purposes other than that of handling stone; and it saves time because it is always an easy matter to have a properly sharpened drill on hand when it is wanted. There is no temptation to use a dull drill because of the need of awaiting delivery from a distant shop or because of lack of energy to carry one by hand for some distance. When the drilling location is changed, it is a simple matter for one of the quarry locomotives to move the shop. Drilling as a rule is carried on at only one point at a time.

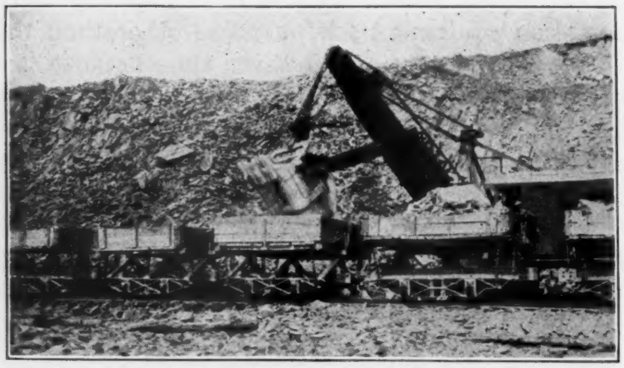
The rock is picked up and loaded by three Marion steam shovels. There is one 60 and one 70 ton machine on the lower bench and one 70 ton on the upper bench. The 70 ton machine on the lower level is provided with Marion crawling tractors and the two others will be so equipped in the near future as they save a great deal of labor. These shovels have given extremely satisfactory service. The 60 ton machine has seen fifteen years of service and the two 70 ton machines twelve years. The secret of this performance is that they have been given reasonable care from day to day. Oiling and greasing is regularly attended to, and they are given a careful overhauling every winter during the months when operations are at a standstill. In fact all the machinery in the plant is gone over at that time.

The stone is loaded by the shovels into six yard Western side dump cars ten of which make up a train. They are hauled by standard gauge Vulcan locomotives of which there are four in the quarry.

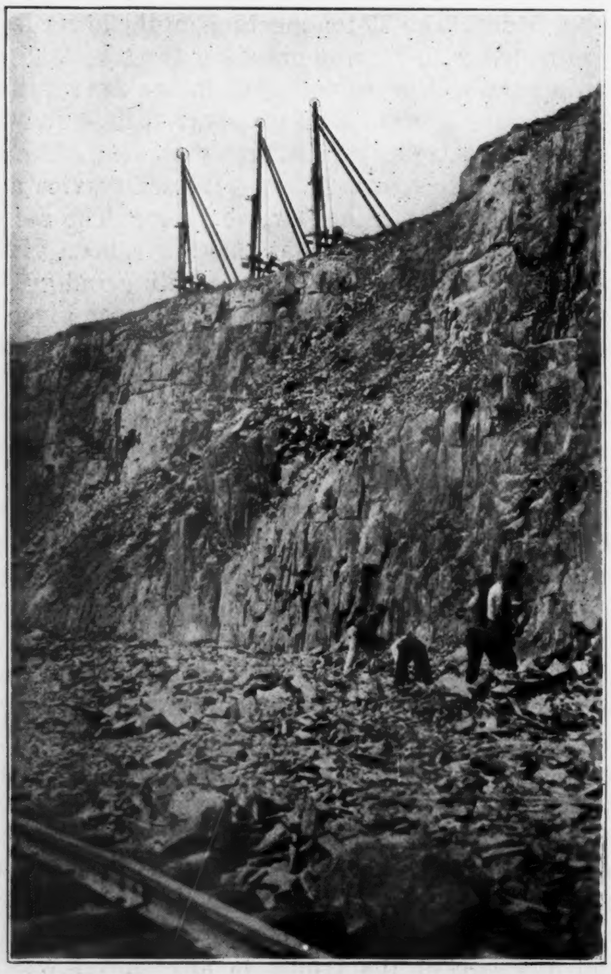
Cars filled with stone from the quarry are hauled into the top building of the crushing plant, and dumped one by one into the primary crusher. When the last load has been discharged, the train passes completely through the building, after which it is switched around the end of it and is then dispatched back to one of the steam shovels. There are four trains for the three shovels in the quarry. As unloading takes much less time than loading these four trains keep busy the shovels as well as the primary crusher. The tracks and switches are so arranged that it is a perfectly simple matter to send any one of the trains to any shovel which would otherwise be idle.



General View of Quarry



Loading Cars in Quarry



Drills at Work on Top of Bench

The crushing plant, as has already been mentioned, is located on the side of the hill so that it is not difficult to provide for the progress of the stone through the various crushing and screening operations.

When the stone is dumped from the cars it drops into a 48x72 Buchanan jaw crusher which takes stone about the size of a man's body. From this it drops in pieces about the size of a man's head into a Number 10 Allis-Chalmers gyratory crusher. The gyratory crusher discharges into a 30-inch Robins belt conveyor which carries the stone to an Manganese Steel Forge Company's rotary scalping screen equipped with a jacket.

All of the material which passes through the jacket is of commercial size and drops through a chute to a 20-inch belt conveyor which in turn discharges on to a main 30 inch belt conveyor to the sizing screens.

The stone which does not pass through the scalping screen drops to a conveyor carrying it to three Number 6 Allis-Chalmers gyratory crushers. The stone which passes through the screen but not through the jacket falls through a chute to two Number 6 Allis-Chalmers gyratory crushers.

The stone from the Number 6 crushers is picked up by a belt conveyor and is delivered by it to a pair of secondary rotary scalping screens. The troughs are commercial sizes and drop through chutes directly to the main 30 inch conveyor which carries them to the sizing screens. The overs are distributed by gravity to four Symons disc crushers. From these last crushers the stone is taken by means of a belt conveyor and elevator to a final scalping screen. As before the troughs drop to the main conveyor and are carried to the sizing screens while the over-sized pieces are dropped back again to the disc crushers.

The belt conveyor which carries the commercial sizes to the sizing screens is about 215 feet between centers. Similarly to all the other belt conveyors used at this plant the mechanism has been supplied by the Robins Conveying Belt Company, but the belts themselves have been obtained from the Manhattan, U. S. Rubber, and Boston Woven Hose and Rubber Companies. The last named has supplied the belt for the conveyor to the sizing screens. Crescent and Dreadnought belt fasteners are used.

There are four sizing screens arranged in two pairs, which as well as all the screens in the plant, have been secured from the American Manganese Steel Company. The first pair separates out the 2 inch and 1¼ inch sizes which are dropped into the proper storage bins. The throughs are dropped to a short belt conveyor which takes them to the second pair of rotary screens. Here the ¾ inch, ½ inch and screenings are separated and allowed to fall into their respective bins.

At this point we come upon another operation which is not common. There is a demand in this territory for crushed stone of mixed sizes—not always a mixture of all the sizes which when rolled makes a compact and hard bed. To obtain this mixture by strictly mechanical means a belt conveyor is run under the bins and up an incline to a hopper. When any given mixture is desired the conveyor is set in motion and the spouts under the appropriate storage bins are opened. As the material falls out into the hopper at the other end of the conveyor, it becomes thoroughly mixed. The hopper is provided with a spout for loading freight cars.

Formerly the screenings were waste material but now they are used for asphalt filler, state highways, private driveways and for other purposes so they are placed in storage bins just the same as the standard sizes of crushed stone.

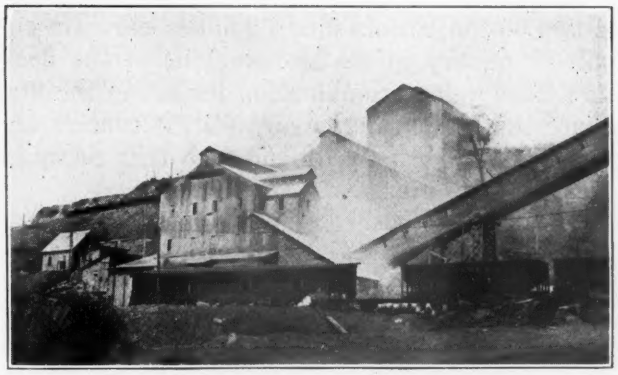
The storage bins already mentioned are equipped with spouts for loading the company's 50 ton steel gondola cars and 12 yard Western side dump cars and standard railroad freight cars, for which purpose there is a line of track in the proper position as shown in one of the illustrations. In fact there is rather an elaborate private railroad yard at the bottom of the plant with switching facilities for handling the extensive loading operations which must be carried on here. A Porter locomotive is used for this switching service in this yard.

The quarry and crushing plant are located about five miles north of the shore and four and a half miles north of the main line of the New Haven Railroad. The company maintains its own line of standard gauge track to its dock which also connects with the railroad. Freight cars may therefore be run over the company's tracks between the loading bins at the quarry and the main line.

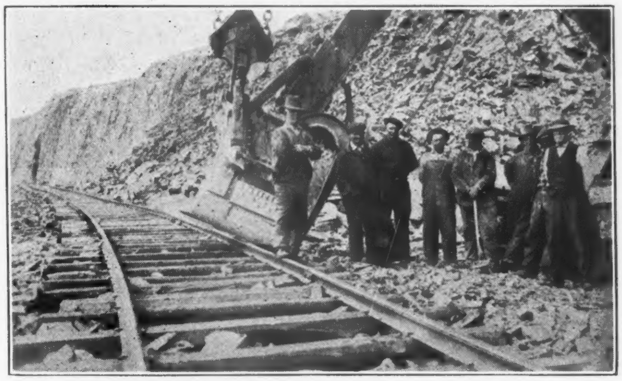
A large size locomotive owned by the company is used to haul trains of dump cars to the dock as well as the railroad gondola cars. It also owns six 50-ton gondola cars and forty 12-yard Western side dump cars which are used for local transportation between the quarry and the dock.

Near the intersection of the railroad from the quarry with the New Haven Railroad and about one mile from the dock there is a storage yard for surplus crushed stone where the loaded cars are run up on a trestle and dumped. Parallel to the trestle and well separated from it is a line of track on which a Brown hoist with a 50-foot boom operates. In the first place the hoist is used to pick up stone from under the trestle when that space becomes filled and store it on the opposite side of the track. It is also used to load the 50-ton gondola cars which are used to carry material down to the dock for water shipment. This hoist will load a 50-ton car in 20 minutes and although it has been in operation for 12 years, it has been so well taken care of that it is still in good condition and there is no thought of replacing it. A Porter locomotive is used for taking cars loaded by the hoist down to the dock.

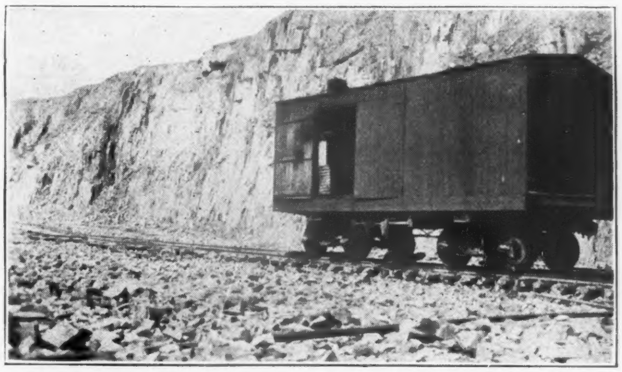
This storage is extremely useful as the space is well filled in the early spring before the demand



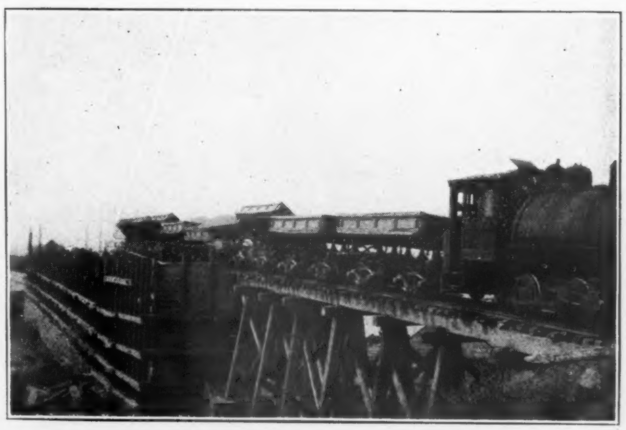
Crushing Plant, with Conveyor Housing at Right



The 70 Ton Shovel Crew



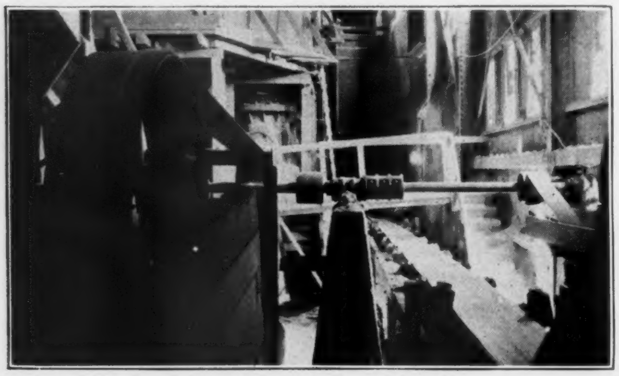
The Portable Drill Sharpening Shop



Train of Cars Discharge to Storage Bins

equals production, and it is ready for the rush later when the quarry cannot produce fast enough to satisfy the demand. As much as 60,000 tons has been stored here at one time.

Trains of twelve 12-yard Western side dump cars and two 50-ton bottom dump gondola cars are run from the quarry to the storage bins at the dock. This makes a good combination for filling the bins because the bottom dump cars fill the centers and the side dump cars fill the sides so that no space is wasted in the bins.



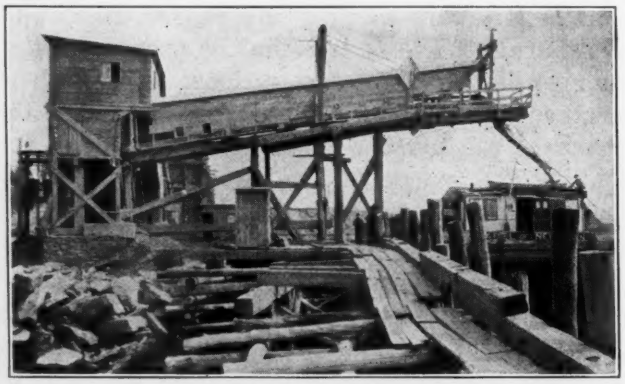
Belt Conveyor from First Scalping Screen

Bottom of No. 10 Gyratory Crusher Located Below the Primary Jaw Crusher

The loading facilities at the dock have been worked out so as to make use of the most modern labor saving facilities. There is a line of storage bins for the various sizes of about 600 yards' capacity each, into which the stone is dumped from above directly from the cars. Underneath these there is a 30-inch Robins belt conveyor about 315 feet long used for loading barges. This conveyor discharges to a hopper, which supplies another belt at right angles to it. The stone then falls into a universal chute for loading the boats at the dock.

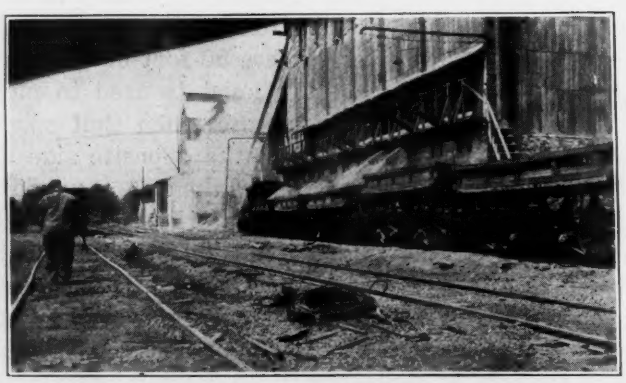
Of course it is necessary to move the boats along the dock gradually as they are being loaded. This is accomplished by means of a motor driven hoist made by the National Hoisting Engine Company.

Near the dock is a very large waste pile of screenings accumulated during former years when there was no demand for this kind of material. It is an interesting fact that it is now being sold. To assist



Arrangement for Loading Barges

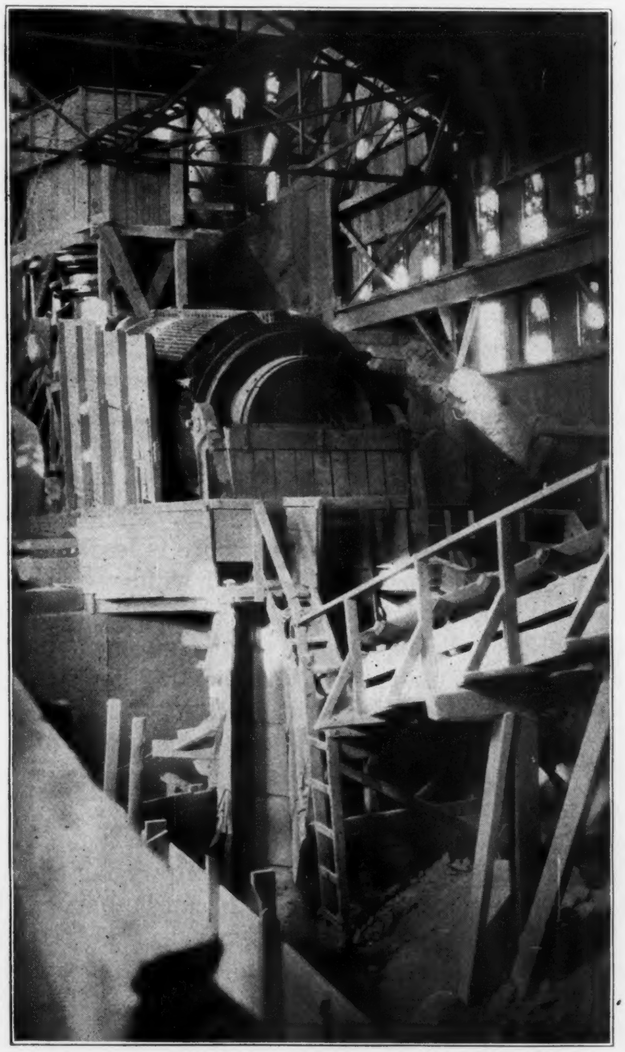
The Mixed Stone Loading Bin



Loading a Train of Cars at the Storage Bins in loading trucks a small derrick hoist driven by a Novo frost proof gas engine has been installed and the statement is made that a considerable amount of material is now being disposed of in the neighborhood of Branford and other nearby places.

Current in the plant is purchased from the United Illuminating Co. at 6,600 volts three phase and is stepped down by a bank of general electric transformers to 550 volts. All of the motors in the plant are General Electric induction motors operated at that voltage except the one which drives the Ingersoll-Rand Imperial Type number 10, 18x 14, 950 foot compressor. The drive for this is a synchronous motor rated at 185 h.p. As the air compressor runs all the time, and requires a good deal of power it is the best machine in the plant to operate in this way from the standpoint of power factor correction. The power transmission belts and belt fasteners have been supplied by the same companies which have furnished the material for the conveyors.

Storage Yard Where Surplus Is Kept



Primary Scalping Screen with Secondary Crusher Below

VALUE OF GYPSUM DEMONSTRATED

By Ellison Munday

There are local field experiments on record that represent several communities to prove the good results of gypsum. Yields of alfalfa and clover have been increased over 100 per cent after gypsum was applied.

Gypsum or land plaster gives its results largely through stimulating the nitrogen bacteria. The legumes are capable of storing more nitrogen which is then available for plant food. Calcium and sulphur that are contained in land plaster are plant food elements also.

One of the better methods of determining the action of gypsum is for interested farmers to test gypsum on their meadows. Gypsum is usually applied at the rate of 300 pounds per acre and can be applied with straw or manure.

MISSION PORTLAND CEMENT COMPANY MAKES IMPROVEMENTS

The old Mission Portland Cement Company plans to spend $750,000 for improvements at its San Juan plant this year according to an announcement made by the officers of the company.

The company plans to construct an aerial tramway to bring the raw material to the plant, replacing the raliroad now being used. The tram will have its starting place at the base of Freemont peak and will be approximately five miles in length.

In addition to the tram other improvements will be made. The company spent $250,000 at the plant last year so the improvement outlay will amount to a million dollars in two years.

U. S. GYPSUM COMPANY TAKES ACTION AGAINST PACIFIC PORTLAND

An action for damages for alleged infringement of patent and accounting for profits, alleged to have accrued, were asked in an action filed in Federal Court recently by the United States Gypsum Company of Chicago against the Pacific Portland Cement Company, Cons., of California.

The complaint sets fort that prior to March 8, 1920, Harry E. Brookby of Evanston, Ill., was the original inventor of a process for aging calcined gypsum products. Brookby was granted a patent, said the complaint, and was given permission for seventeen years to use the exclusive right of practicing the process.

FUELS BURNED IN LIME KILNS

By Charles Longenecker

THE combustible elements in all fuels are carbon, hydrogen and sulphur. These elements, when combustion is complete, form, with oxygen, carbon dioxide, water and sulphur trioxide. Other constituents, in the solid fuels, are iron, silica, alumina and calcium. Such ingredients are undesirable, as they form the ash, and hence the lower in percentage the more acceptable the fuel. Water is another component of solid and liquid fuels, which may be classed as undesirable, except in so far as it exerts a beneficial effect in kiln operation.

The fuels which will be considered are:—

Wood.

Oil.

Gaseous Fuels.

In bygone days when wood was plentiful it was used exclusively and with very satisfactory results. In many industries wood was not burned in the raw state, but was converted into charcoal, in which form there is greater concentration of heat per unit of weight. The heat value of soft wood is generally higher than that of hard wood. There is a great variation in the B. T. U. content of wood as given by authorities. This is due to the amount of moisture in the wood when tested. When air dried the B. T. U. content per pound will average 5,000, for the hard woods and 6,600 for pine, polar, spruce, willow and hemlock. When first cut the moisture content will run from 35% to 50% but, when well dried, this content will be reduced to from 10% to 20%. Kiln dried hard wood will have a heat value of 8,500 B. T. U. per pound while soft wood will run as high as 9,000 B. T. U. A chemical analysis of nine varieties of wood gave:

Carbon	49.2%
Hydrogen	5.6%
Oxygen	43.8%
Ash	1.4%

The ash will generally run from 1 to 5 per cent. Due to the fact that the ash is so small in quantity and contains no harmful ingredients it makes an ideal fuel. Normally 2½ lbs. of wood must be burned to obtain the same heat as is secured from one pound of coal. Compared to coal, wood has many advantages, but the cost, for an equivalent amount of heat, has precluded its use, except in exceptional localities.

Fuel Oil

There is no better fuel, from many viewpoints, than oil. It is easily distributed, can be burned with a high efficiency and has a high B. T. U. value per pound. The uncertainty of price and supply has hindered its extensive use. An analysis of various oils shows quite a variation as is readily seen from the following table compiled by C. E. Lucke:

	Specific Gravity BE'	Carbon	Hydrogen	Sulphur	B.T.U. Value per Pound
California Fuel	14.93	81.52	11.61	.55	18926
California Crude	16.24	86.30	16.70	.80	21723
Beaumont Fuel	21.25	83.26	12.41	.50	19654
Beaumont Crude	21.56	84.60	10.90	1.63	18977
Pennsylvania Crude	23.18	86.10	13.90	.06	20947
Kansas Crude	31.67	85.40	13.07	....	20345
Ohio Crude	38.89	85.00	13.80	.60	20752
Mexico	21.90	83.70	10.20	4.15	18840
Russia	19.30	86.60	12.30	....	20138

The variation in sulphur content between Pennsylvania oil and Mexican is quite great. The Beaumont, Texas, crude, also shows high sulphur. This is the harmful element in oil and should be low. Pennsylvania oils are the most desirable but are sold at a higher price than the Texas or Mexican grade. The former has a paraffin base while the base of the Mexican oil is asphaltic and, in consequence, is not as fluid as the other American oils. As a rule, the heavier oils are heated and passed through a strainer before reaching the burner. All oils should be strained as they contain considerable grit. The density and volume, with degrees BAUME, are shown in the table prepared by the Bureau of Mines which follows:

Degrees Baume	Pounds per Gallon	Gallons per pound
10.0	8.328	.1201
15.0	8.041	.1244
20.0	7.772	.1287
25.0	7.522	.1330
30.0	7.286	.1373
35.0	7.065	.1415
40.0	6.867	.1459

One barrel contains 42 gallons and will weigh approximately 336 lbs.

Oils give off, at a low temperature, inflammable vapors. The temperature at which these vapors will ignite is termed its "flash point." The higher this temperature the better as there is less trouble experienced in storaging and in burning with oils having a high "flash point." The United States Navy Specifications state that the flash point "shall never be under 150° F." They further specify that the water and sediment shall not exceed 1%.

In every locality there is some one grade of oil which is most acceptable due to price and delivery and the purchaser must determine whether it will be economical to burn oil or some other fuel. The cost of handling and distributing oil are factors in its favor as compared to coal. It can be burned at a higher efficiency than coal provided the proper type of burner is installed. In the burning of oil there are several factors to be kept in mind. Atomization should be as thorough as possible so that a most intricate mixture, with the air for combustion, can be obtained. With a thin oil atomization is more complete and more easily secured. Quick ignition is imperative as otherwise there will be a loss of combustible in the waste gases. It is not easy to burn oil efficiently unless the furnace design is proper. In fact, while the burner is a most important feature, the furnace construction is just as important. Oil is composed of hydrocarbons, and in burning, these break down into hydrogen and carbon which must be united with oxygen to form carbon dioxide and water. Therefore the oil must first be gasified and the heavy hydrocarbons broken down to simpler forms and these in turn split up to carbon and hydrogen. This requires heat so that the best results will be secured when the entering oil and air pass through a high temperature zone immediately on leaving the burner. Heat alone will not effect complete combustion unless the necessary oxygen is in contact with the carbon and hydrogen. Both heat and intimate mixture of the elements are necessary for the most efficient combustion.

Gaseous Fuel

Coal is the most important fuel available as it can be used in the raw state or it can be converted into a gas. Only certain features, regarding this fuel, will be discussed here as, in past issues of Pit and Quarry, the discussions have been quite complete.

There is a decided trend today toward the use of gas, made from coal, in all types of kilns and furnaces. This is a national trend as it has, as its object, the reduction of fuel costs. Producer gas, coke-oven gas and combustible gases generally can be burned with higher efficiency and also at a lower cost than other fuels. To the lime manufacturer the gas producer is the only equipment that holds any interest. This machine has been vastly improved in recent years, especially as regards mechanical and automatic operation. The "handpoked" machine is rapidly being discarded due to the cost of labor involved in its operation and lack of uniform gas supply and heat value.

The analysis of gas from a producer will approximate:

CO_2	8.96%
CH_4	3.19%
CO	16.23%
H_2	11.30%
N_2	59.79%

This gas was made from a coal of the following composition.

	Ultimate Analyses		Proximate Analyses
Carbon	70.95	Volatile Matter	35.35
Hydrogen	5.25	Fixed Carbon	44.50
Nitrogen	1.37	Moisture	12.55
Ash	8.65	Ash	7.60
Sulphur	1.76	Sulphur	1.54
Oxygen	12.02		
B. T. U. per cu. ft. 11445.			

This coal is not high grade as the moisture and ash content are too high, which is true of most Western coals. The B.T.U. content of the gas per cubic foot is 125 which is low. A good Eastern gas coal such as Westmoreland will give a gas having a B.T.U. value per cubic foot of from 140 to 160 with 150 as an average.

Gas producers are made in several sizes with the capacities varying accordingly. A producer 10 ft. in diameter will gasify 3000 lbs. of coal per hour when fed with coal of a high grade. From one pound of coal 55 to 65 cubic feet of gas can be obtained. A 10 ft. diameter producer requires a 5 H.P. motor to drive it and will be blown with about ⅓ lb. of steam per pound of coal gasified. The air passing through the producer approximates 45 cu. ft. per pound of coal. Today the turbo-fan blower is rapidly surplanting the steam yet as it is more efficient and less steam is required while pressure control is more easily adjusted.

The principle underlying producer operation is not complex, but the various reactions between the elements of the coal and the air and steam, are not thoroughly understood. The steam is split into hydrogen and oxygen. This oxygen, together with that of the air, combines with the carbon of the coal and CO is formed. The combustible gases are this CO, together with the hydrogen, derived from the steam, and any hydrocarbon gases distilled from the coal. In the gas analysis shown the nitrogen forms 60 per cent of the volume of the gas. Unfortunately the percentage of nitrogen cannot be reduced as it forms 79 per cent of the volume, of a cubic foot of air, and accompanies the oxygen of the air blown into the producer. The coal itself contains a small quantity of nitrogen but the amount is insignificant in comparison with that in the air.

In considering the installation of gas producers the individual conditions at the plant must be fully appraised. The cost to gasify a ton of coal will be about $1.10. This must be added to the cost of the coal. The initial outlay will depend on the cost of building, bins, coal handling equipment, length of piping, etc. What this amount will be can only be determined by a survey of the plant layout. The closer the producers are to the kilns the better as the gas will be hotter when it reaches the burner. As a rule the temperature of the gas as it leaves the producer will average 1300° F. The higher the temperature of the gas, when it unites with the air, the more complete the combustion. As the heat content of a cubic foot of gas is low it is necessary, when high temperatures are desired, to heat the air used to burn the gas.

In designing the gas piping it is always advisable to provide ample openings for cleaning as there will always be a deposit of soot. This is especially the case when the producers operate too hot. Irregularities in the gas analysis and volume come from bad conditions in the fuel bed of the producer. If cracks develop in the bed the steam and air will pass through without coming in contact with the carbon of the coal which means high CO_2 and H_2O in the gas. These inert gases reduce the heat value.

The efficiency of the producer will depend on the temperature at which the gas is burned. Where the gas is allowed to cool the efficiency will be no higher than 75 per cent while if it is burned hot 85 per cent may be obtained.

INCREASED DEMAND FOR CEMENT PREDICTED BY NEW YORK TRUST

Productive capacity in the Portland cement industry is increasing faster than the demand for that product, according to *The Index,* published by the New York Trust Company.

"By the end of 1926 the Portland cement plants of the country will have a producing capacity estimated at 200,000,000 barrels annually," says *The Index.* "The known plans for new buildings, railroad construction, public service work and highways indicate a probable annual demand of about 160,000,000 barrels. With a potential excess of 40,000,000 barrels above an adequate supply, the industry faces, therefore, the necessity of guarding against over production of this staple building material.

"If demand is to catch up with the industry's enlarged productive capacity, the increase will have to take place chiefly in road construction, which consumes about 22 per cent. Neither of these activities gives any indication of a marked increase in cement consumption.

"Plans for both government and state road building call for approximately the same quantity of cement as has been used during the past five years. Likewise, it is not believed that there will be any marked expansion in the present construction of buildings. That the present rate of building activity is not increasing is indicated by the fact that the April figure for contracts awarded was only 1 per cent greater than in the previous year, while in January the figure was 48 per cent greater."

ALVIN E. DODD COMMENTS

The relation of supply and demand at the present time was discussed by Mr. Alvin E. Dodd, manager of the department of domestic distribution of the Chamber of Commerce of the United States, in an address on June 17 before the Society of Industrial Engineers in Philadelphia. The old problem of creating a supply for an existing demand has changed to that of securing a demand for surplus production. "While our growth in population has been material," Mr. Dodd said, "it is only about 16 per cent above that of 1913; but accepting 30 per cent as the increase in the facilities for manufacture, a capacity exists seriously in excess of what might be called normal demand based on pre-war rate of production." That the distribution problem merits serious thought was made clear in the address.

PUTTING UP A PLANT QUICKLY

In the neighborhood of Columbus, Mississippi, there is a wealth of good, clean sand and gravel suitable for concrete aggregate, masons' sand, locomotive sand and asphalt filler. Between the Tennessee river and the town of Bigbee it is estimated there are at least a million car loads of material yet to be excavated.

On the banks of the Tombigbee river the deposit is estimated at 6,000 cars of gravel. It is this later deposit which is being worked by the Tombigbee Sand and Gravel Company which has its headquarters at Columbus and its pit at Bigbee. The operation started in August, 1924, when G. E. Hauser, vice president of the company and superintendent of operation, made a survey for a 3,600 foot switch track from the Frisco Line tracks to the bank of the river. Less than seven weeks later he has built the switch, 750 feet of which was on trestles over slews, built a screening plant 14x16x32 feet high, brought an electric power line two and a half miles from Amory, and put into operation a Sauerman slack line cable way with a 2 yard bucket.

After the plant was started little difficulty was encountered. The screen frame was built of 10x10 lumber and is capable of delivering two cubic yards of gravel each minute to the slope screen which is built over the railroad tracks. Screening and loading into cars are identical operations. The plant is operated by 8 men including the locomotive engineer and fireman and the hoist operator. J. T. Sanford is president of the company and Henry M. Beard, treasurer.

RECORD SAND, GRAVEL AND STONE LOADING

All previous records for stone, sand and gravel loading were broken when 83,441 cars of these materials were loaded by producers and transported by the railroads during the week ended May 29, 1926. This is the first time in the history of the industry that stone, sand and gravel loading has exceeded the 80,000 car mark.

The loading of 83,441 cars for the week ended May 29, 1926, shows an increase of 4,439 cars over the preceding week, an increase of 15,140 cars over the corresponding week of 1925, and an increase of 27,847 cars as compared with the same week of 1924.

The loading of stone, sand and gravel for the week ended June 5, 1926, was 73,661 cars. This represents a decrease of 9,780 cars under the preceding week, an increase of 850 cars over the corresponding week of 1925 and an increase of 11,703 cars compared with the same week of 1924.

This decrease of 9,780 cars is due to the fact that May 30 fell in the week ended June 5, 1926. The increase of 850 cars over the corresponding period for last year would undoubtedly have been considerably higher but for the fact that May 30 was not included in the corresponding week of last year.

KEEPING A CRUSHED STONE PLANT EFFICIENT

HOW G. D. FRANCEY DOES IT IN WISCONSIN

By E. D. Roberts

MOUNTING labor costs, higher priced materials, competition that cuts prices to the "bone" coupled with more exacting specifications and inspection have caused many crushed stone operators to take an inventory of the situation and look for a remedy. An expert from some machinery manufacturer is called in or perhaps a consulting engineer is employed. In either case advice is wanted. After a careful inspection of the plant, many changes are ordered and if the plant is old, much new equipment will be recommended. It is hard for the operator to see how he can afford to scrap his old equipment and purchase something new. He has used that old machinery for years without a breakdown or bit of trouble, in fact, he has become attached to it. Seemingly grossly exaggerated statements are made in support of the saving to be made by the replacement. However, he is up against it and orders the change as a last resort. After operating under the new conditions for awhile, he wonders how he got along with the old plant.

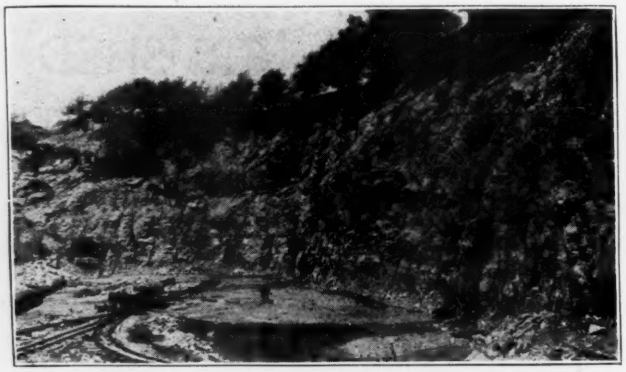
Other operators make changes in plants gradually. They keep their ears to the ground looking for any improvement that will benefit them and if the machinery salesman is able to convince them of added profits, they order the change. In this manner, as time goes on, their plants are kept up to date and at no great outlay of funds at any one time. It is in this way that the management of the G. D. Francey Coal, Stone and Supply Company of Wauwatosa, Wisconsin, has kept the plant efficient both in quality and quantity of production although the plant was first built many years ago.

The latest addition to this plant is a double deck vibrating screen. This vibrating screen separates the dust from the 5/8 inch material. This refinement has become necessary in a more exacting market. The Lippmann vibrating screen is a force feed affair which will even force the material up hill should it be desired. This feature allows the placement of the screen at such an angle that sand or gravel will not run over it by gravity in case of power failure and prevents spoiling a bin of material by power failure. The double deck feature gives a greater classification of the material in a short space.

A Blaw Knox steel batching hopper is now being erected to furnish properly mixed aggregate to any specification. The concrete foundations for an additional unit are in place and the erection of the second hopper will be started as soon as the present one is in operation. These hoppers have been constructed alongside of the spur track serving the

The Storage Unit of the G. D. Francey Coal, Stone and Supply Company. Note the Easy Access for Trucks


Drilling Boulders with Air Drills


Looking Into the Quarry from Shovel Towards Switch

plant. Sand is brought in by rail in bottom dump cars. By opening the bottom gates of the cars, a large part of the sand will flow directly into the hopper constructed to lead the sand to the inclined bucket elevator that will raise the material to the top of the hopper and discharge it into the desired compartment. A 15 h.p. General Electric motor mounted on a platform drives the elevator from the head pulley.

That part of the car load which does not flow into the hopper by gravity will be handled into the hopper by a one-yard Hayward clamshell bucket operated by a large overhead derrick. This derrick will also handle the crushed stone into the hopper from an outside storage pile created by a spout leading from the revolving screen out through the side of the screening shed that is constructed over the crushed stone bunkers. The derrick hoist is of the 4 drum Thomas Elevator type operated through reduction gearing by a two speed electric motor.

This derrick is not able to cover all of the ground storage area at present. Special tracks allowing the derrick to move up and down the yard previously allowed access to all parts of the yard, but the construction of the Blaw Knox hoppers has rendered this impossible and as a consequence a Barber Greene bank loader has just been installed to load trucks from any of the storage piles.

Another very recent addition to the plant which causes Mr. Francey great satisfaction is a one-yard number 208 P. & H. electric shovel. This shovel loads the rock into the cars in the main quarry during the rush season and does the yard loading from storage during the slack seasons. Material frozen in the piles has no terrors for this shovel.

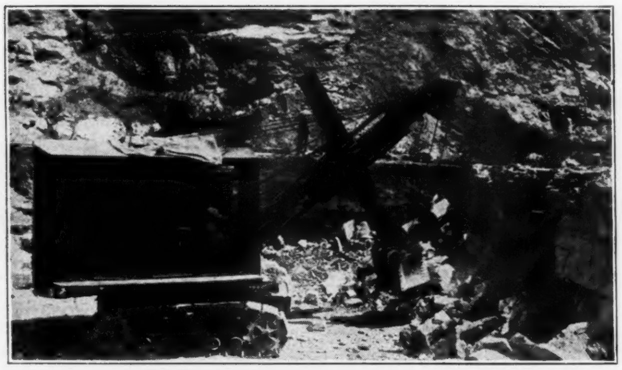
The replacement of coal burning steam engines by 2 Fairbanks Morse oil engines producing 400 h.p. at a daily cost of $9.00 fuel against a $20.00 fuel cost for the steam engines, which produce but 200 h.pp., in addition to eliminating two men, is a good example of some of the changes that can be made in existing plants and at the same time show a remarkable saving. A spur from the C. M. & St. P. R. R. has been laid to the quarry.

Wauwatosa is a suburb of Milwaukee and all of the west and business sections of Milwaukee are served advantageously from the plant. Stripping of from five to twenty feet of overburden is removed during slack times by the electric shovel and the material used to fill and reclaim marshy lowlands along the Menomonee River, which flows close by.

As can be seen by an inspection of one of the illustrations, the upper part of the rock strata was what is called "bastard" rock which caused considerable drill trouble to the ordinary drill. By resorting to the use of a Loomis Clipper blast hole drill, this trouble was overcome and good results obtained. The lower part is a very hard stratified limestone and is easily taken out in benches by short holes put down by Ingersoll-Rand jackhammer drills. The holes are shot with Grasselli 40 per cent gelatin. Extreme care has to be exercised in shooting due to the proximity of the State Street


Shovel Loading in Quarry


Quarry Showing Car Coming Up Incline



Another Quarry View

Highway and the encroachment of dwellings as the city closes around the quarry. The large boulders are drilled and a charge placed therein. This method of breaking them up does not cause the shower of rocks experienced in "bulldozing." The electric shovels load the 4 yard Western side dump cars to capacity. These cars are allowed to run by gravity past a switch and after throwing the switch the car is allowed to run back through the switch to the foot of the incline. An electrically operated Clyde hoist hauls the car up a steep incline to the point where it is side dumped directly into a number 12 Allis-Chalmers breaker. After dumping, the car is allowed to run down the incline but still is controlled by the hoist. A spring switch on the incline diverts the empty car onto the run around track located at the foot of the hill.

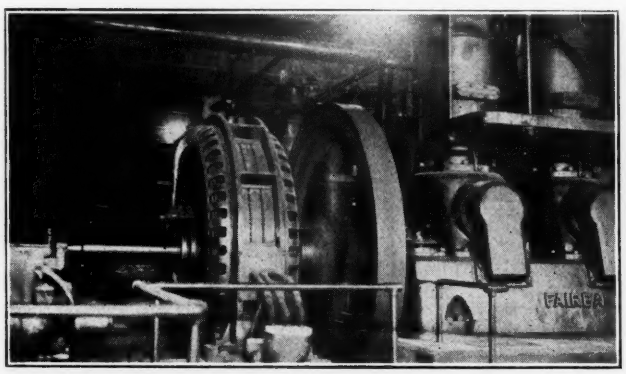
After passing through the breaker, the crushed rock falls into a large hoppered bin constructed below the breaker. A reciprocating feeder draws the rock from this bin and feeds it to a number 8 Allis-Chalmers inclined bucket elevator. This elevator discharges into the reduction crushers. These crushers, a number 5 Telsmith and a number 4 McCully are located so that the rock may be fed to either or both of them by a deflector in the spout from the number 8 elevator.

The two reduction crushers discharge into a common chute leading to a number 7½ Telsmith inclined bucket elevator which discharges into a chute leading to another Telsmith bucket elevator which in turn discharges the crushed rock into the

Derrick Handling Crushed Stone to Hoppers

revolving sizing screen in the top of the building over the storage bunkers.

The revolving screen, furnished by Toepfer, is 60 inches in diameter and 20 feet long. A special feature of this screen is an extra inside screen section for the first 8 feet of the screen. This extra section has 1½ inch perforations and is provided to keep part of the material from coming in contact with the regular ¾ inch section which saves wear on it and at the same time speeds up the passage of material through the screen. A 72 inch by 6



The Power Plant

Loading Trucks with Derrick

feet sand jacket placed over the upper end of the main screen sorts the fines and chips and number 1 rock from the larger rock and discharges them onto the Lippmann double deck vibrating screen which takes the dust out of the fines and separates the fines from number 1 rock. Additional sizes produced by the revolving screen are ¾ inch to 1½ inches; 1½ inches to 2 inches and rejects. The rejects are chuted back to the Telsmith reduction crusher while the other grades are chuted to their respective bins below. In case it is desired to chute directly to outside storage piles, spouts have been arranged to lead the material from the screen through the walls of the building. Additional ground storage is provided by drawing off the material from the bins into trucks and dumping it on the outside piles.

The fines and chips are sold for the manufacture of concrete blocks and brick as well as for the construction of driveways. Concrete sand is shipped in from outside pits by rail and unloaded by the electric derrick and clamshell bucket.

Deliveries to the trade are made by a fleet of 6 trucks owned by the company. These trucks are equipped with full pneumatic tires. Heil dump bodies operated by the Wood hoist are placed on all of the trucks.

Power for plant operation during the day is furnished by the two 200 horse power 2 cycle 4 cylinder Fairbanks-Morse Y oil engines, each directly connected to a 170 k.w. 60 cycle 3 phase 230 volt Fairbanks-Morse generator. Excitation is furnished by a 7½ Fairbanks-Morse exciter. The voltage, phase and cycle are the same as that furnished by the Milwaukee Electric Railway and Power Company for plant use when the Y oil engines are not running. This connection to the Electric Company's wires provides for power to operate the pumps during the night or when their own power plant is down. Three Allis-Chalmers centrifugal pumps keep the quarry free from water—one throws 1,500, another 400 and the last 200 gallons per minute. These pumps are equipped by directly connected motors. By day the electricity for motor operations comes from the plant powerhouse and by night from the Electric Company's power lines.

There are two Ingersoll-Rand air compressors each operated by a 50 h.p. General Electric motor through belt drive and gravity tightener. Individual motor drives are provided for each of the elevators, crushers, screens, etc.

A Lippmann Manufacturing Company inclined bucket elevator has been provided to rework any of the sizes produced. A truck draws this material from the bin or the truck is loaded by the clam shell from outside storage. The load is discharged into a hopper that feeds to the elevator which discharges the material into the number 4 McCully reduction crusher for further crushing.

NOVEL LOADING METHOD

The Seymour Creek Sand and Gravel Company, Ltd., conducts a hydraulicing operation on the north side of Burrard Inlet just outside Vancouver harbor. The land is owned by the Harbor Sand and Gravel Company, Ltd., and is operated under a lease. The property consists of 22 acres and is especially adapted to masonry purposes.

Water for the hydraulic operation is pumped by a McDougal Iron Works pump from Seymour creek through a 10 inch wire wound wood pipe manufactured by the Canadian Wood Pipe Company for a distance of 4,000 feet. The deposit is a bank 130 feet high but in order to handle the material without elevating it the operation was started 75 feet up the bank. This left a working face of 55 feet.

The washed down material is fumed into the screening plant which is built on top the storage bunkers situated at the bottom of the hill. The screening plant, manufactured by J. Coughlan and Sons, consists of four units, the first is a 2½ inch screen, the second a 1½, the third a ½ and the last 5/16 inch. Besides these there are two sand boxes. Below the bunkers is the crushing plant consisting of a Universal and an Allis-Chalmers Crusher. Tailings from the first screen are chuted here and returned to the screen by a bucket elevator with Dunlop belting.

The bunkers which have a capacity of 1,000 yards are divided into ten compartments and the material can be shipped by water only there is the problem of conveying the finished product to scows. The distance to deep water is 3,000 feet. In order to get scows to the bunkers a channel has been dug 70 feet wide and 10 feet deep. This fills with water at high tide but there is sufficient water in the channel 3 hours before to allow the empty scows to be towed up and loading to start before the tide turns back. A 30 inch Dunlop conveyor belt 400 feet long running underneath the bunkers elevated the material to a hopper from which it is chuted into the scows. This belt loads at the rate of 200 yards an hour. The entire operation is electric.

BANKER SEES STEADY PROGRESS

Striking an aptimistic keynote for the future Mr. Lewis E. Pierson, chairman of the board of the Irving Bank-Columbia Trust Company and vice president of the executive committee of the Chamber of Commerce of the United States, addressed the New England Bankers' Association on June 7. Mr. Pierson's subject, "Team Play and Progress," led him into an analysis of the industrial and business situation at the present time. "With managements and labor working together to increase the productivity of American factories, with every part of our industrial structure cooperating to perfect the processes of business, we can move steadily forward to even better things, toward a future which will be rich with deserved achievement."

THE PRACTICAL ASPECTS OF RESEARCH

By G. J. Fink, Director, National Lime Association Laboratories*

RESEARCH is always found in both the vanguard and the rear guard of sound and successful promotion of any product. As one of the advance forces it must develop information and data by means of which new roads are opened in attack and with which safe bulwarks of facts may be built up in defense. Behind the lines it must be continuously bringing up new forces and ammunition in the form of further or different facts and results, and must be building up a reserve of new uses, methods or processes to be rushed up as the original forces become out-of-date and useless or to be held in reserve as a defense against counter attacks.

Men and forces engaged in promotion should not be compelled to rely entirely upon precedent. It is helpful to be able to tell a contractor or architect that his fellow contractor or architect in a neighboring city used or specified lime in the concrete for a certain famous job. But we will be still better armed and fortified and much more effective if we can demonstrate clearly and concisely just why lime improves concrete. The Research Department serves and should be utilized as the storehouse of such information as is already available relative to these problems and it proposes and should be expected to develop required data when it does not already exist. To slightly paraphrase an editorial in a recent technical journal "it may be said that the scientific research man and lawyer fight back to back, the researcher looking forward, the lawyer looking backward." Laws and legal decisions are founded largely upon precedent and lawyers are guided by precedent. Science however must be based upon verifiable facts and it is the task of the research man both to present and verify existing facts and to establish or uncover new ones. Then having the facts we can proceed to the formulation of the fundamental principles involved.

The use of lime involves operations all of which are governed by scientific principles and laws, and hence the success of any promotion efforts or of any organization such as ours must depend upon the perfect and happy coordination of scientific facts with business principles. Research by the development of accurate data and the discovery of fundamental principles renders an ever increasing and necessary service while business methods through organization provide for a profitable application of this service. The justification for a research department in any organization is the need for accurate scientific information and fundamental data and the justification for our various promotional departments is the need for a means for applying and using these facts. And here is a principle, in the words of Dr. H. E. Howe, which applies not only to our own staff, but to our member companies as well: "It is the ability to apply the information that makes the difference between the success of * * * rivals."

A promotion organization is inefficient and ineffective if not securely grounded in demonstrable knowledge, and this knowledge defended in every detail by complete and authoritative research. In common parlance we must "know what we are talking about."

But likewise the results of scientific investigations, however extensive and important, are valueless without the means for application. If, as Mr. Elwell of our construction department pointed out, we know that lime plaster has better acoustic properties and is more fire resistant than other plasters, then we can speak authoritatively and the facts are demonstrable. His department must know and likewise member company salesmen must also know in order to capitalize the work of the promotion men. Your serious task as members and as business men is to get the available information used. If you do not have the facts your recourse is to call upon the proper department and if the facts are not available, the research department is expected to get them.

The practical value of research by trade associations was recognized by Great Britain early during the war, and since the war the development of such research organizations by associations has been encouraged by that department of the Government especially set up for the purpose, known as the Department of Scientific and Industrial Research. A million pounds was appropriated by the Government to be used in encouraging association research and pound for pound has been paid for the money expended in the organization of laboratory, equipment and staff. So successful has this been that a second million pounds has been recommended for another five year period.

A number of our competing industries in this country support research organization and still more are being continuously set up. As pointed out by Mr. Carson, president of the Riverton Lime Company, those industries whose products from the beginning have been systematically promoted and whose production and promotion activities have been founded on a scientific basis have shown the most decided upward trend in the curves of consumption. To hold our place with lime we must continue and further extend our efforts in this direction. If we consider lime as a primary material of construction or as a basic material in the indus-

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trial field we should expect that research information concerning it would keep abreast with progress in its utilization. But such has not been the case. It is our hope to set a faster pace in research activities and to refill the well of scientific information which has been all but pumped dry.

So much for the glittering generalities. Let us now see how our own Research Department can and does function. This is best accomplished by surveying a few specific cases of cooperation with other departments, with members, and with users. At the same time let us give some consideration to the lines along which this service can profitably be extended. There are a number of problems to which research has already made definite contributions and also there are almost innumerable questions yet requiring answers.

The National Lime Association Laboratories, as conceived, comprise three closely related units, namely, chemical, physical and research extension, and a three-fold function is performed in the initiation of research, in the investigation of problems suggested by the other departments, members, and consumers, and in the miscellaneous service offered manufacturers and users. This service involves routine testing, laboratory and field investigations, fundamental research, and surveys of scientific and technical literature.

For the construction department facilities are available for testing of mortars, plasters, stuccos, concretes, sands, etc. and for making investigations and analyses to determine the causes for certain favorable or unfavorable results obtained in various conditions. During the second half of the present fiscal year, a large number of complete chemical analyses for these purposes have been made in our laboratory. The category of substances included mortars, plasters, water, sands, brick and boiler scale.

As an example of the use of information already in existence, data which was obtained by the Bureau of Standards on fifty-three plastering sands were plotted and studied and the basis for a specification for a satisfactory sand for lime plaster was developed. This work will be continued and through our Construction Department cooperation with the new technical department of the Sand and Gravel Association will be maintained.

Construction problems on which data is being obtained and on which further work is outlined include: a systematic and thorough study of the how and why of the effects of lime in concrete; lime in concrete exposed to sea and alkaline waters; acoustics of lime plaster; fire tests on lime plaster at average temperatures to supply the required data on its ability to retard small fires; lime and lime-cement mortars below grade; freezing of lime mortars; physical and chemical properties of stuccos. Unquestionable information on these questions must be had if our field men and our salesmen are not to feel unsafe or entirely "at sea" in their efforts.

Much of the data gained from investigations on construction problems will be applicable in the field of highways but there are additional problems peculiar to this department. Soils, for example, must be tested before treatment in order to determine the effects of lime and the proper application, and types not yet encountered must be studied. This relatively new line of activity will undoubtedly uncover many questions which research alone can answer. No better illustration is available of the practical aspects of research than the results of the investigations on lime in asphalt which have been in progress over the past three years. Such questions as "Does lime produce the same effects as other fillers?", "How much lime is necessary?", and "What are its advantages and what are the economies?" were answered only by long and tedious research. We are near the end of this, and approaching the promotion stage, for it appears that we are about to discover a measure for the amount of lime required.

The last of the above questions suggests what is probably one of the greatest and most practical services that our department can contribute. We refer to the questions of economy and the problem of determining relative costs. We know that in most of its uses lime must compete with substitutes, and even if we have clearly demonstrated its satisfactory functioning we have yet to prove its economy. In many of its uses, particularly in the industrial field, this is an intricate problem, and an answer can be found only after a very careful, painstaking and accurate survey and study of several operations and factors. In the glass industry, in metallurgical processes and in the sulphite pulp industries, for example, we have made little progress because we do not have this cost data. Such surveys can be made only by men familiar with the technology of the particular processes and industry, who at the same time are thoroughly trained in the technology of lime. This requires research extension men who will be in a peculiarly favorable position to get this valuable information.

In the industrial field the number of research problems is legion and any attempt to enumerate them here would be useless. We can only touch the peaks. In connection with causticizing and the paper industry, for example, we have countless riddles. What properties of the limes determine the settling rate of carbonate sludges and how can this settling rate of sludges be accelerated? How can rates of reaction be improved and efficiencies increased? In connection with such problems we are utilizing not only our own laboratory and the fellowships but we are also cooperating with the users and with outside interests such as equipment manufacturers and consulting laboratories. Our own work has shown, for example, that greatly improved time efficiencies are obtained by previously slaking the limes and indicating a probable advantage for continuous processes. The fellowship work at Massachusetts Institute of Technology on the solubilities of limes has developed and demonstrated the principles involved in reactions such as causticizing, in which lime functions. A series of tests of a number of limes made by an equipment manufacturer has clearly demonstrated the existence of two decidedly different types of limes in respect to settling rates of sludges and has pointed out avenues for improvement of equipment and procedure.

A very typical example of our service to both producer and consumer is cooperation which we recently gave a paper mill chemist in checking the analysis of his lime supply and in helping to determine the cause of the low efficiencies obtained with this particular lime. The difficulties have apparently been straightened out and the lime manufacturer still holds the business which he was on the point of losing.

Here we also encounter the problem of sludge disposal or utilization and of lime recovery. Efforts are being directed toward the development of attractive outlets for carbonate sludge in order not only to divert it but also to remove one of the chief objections to lime and thus to make causticizing, recausticizing, and caustic recovery much more attractive. As you probably are well aware, one of the competing materials in this field has recently become so cheap, owing to certain economic and industrial conditions, as to make it attractive to users on an equivalent basis and to constrict or eliminate our previous margin. This condition of course necessitates the improvement of lime processes either directly by increase of efficiencies or indirectly by development of income producing by-products. Our research agenda includes both.

Appreciable lime tonnages are being lost in the field of gas absorption. Why? Because in the conditions obtained in many instances lime has been found cumbersome and inefficient. Recent work in our own laboratory and by our fellow under Professor Haslam of Massachusetts Institute of Technology, has pointed out possible ways not only for improving the lime used but also for modifying the conditions of its use so as to overcome these objections.

In the field of trade wastes definite information on the possibilities for use of lime has been sorely needed and we have more or less concentrated on this problem during the past year. One of our fellows under the direction of Professor Withrow of Ohio State University, has been stationed for different periods in three different industrial plants where he has actually applied lime to the plant effluents and has worked out the optimum conditions for satisfactory results. Sugar, strawboard, and pickling liquor effluents have thus been covered.

Creamery wastes have been studied by the headquarters staff and other problems have been attacked under cooperative arrangements. The treatment of laundry waste waters is being studied by an equipment manufacturer and work to date shows that lime is effective. The work of the men under Professor Withrow, who has been directing most of our investigations along these lines, has attracted the interest of certain Boards of Health in the possibilities of lime and private industries and other State Boards are manifesting an active interest. This interest is rapidly extending to sewage treatment problems in general and we believe we are not too optimistic in expecting the development of numerous possibilities in this direction. Our task just now is to obtain accurate information regarding the effects and possibilities of processes using lime in connection with each individual waste or type of waste so that we will be in a position to recommend a definite procedure for each specific case. We are confident that this field is one of our most fertile ones not only for demonstrating the value of research but also for immediate tonnage possibilities.

In the natural course of our contact with plant and research laboratories and with the technical literature new ones are being continuously brought to light. As a raw material and intermediate in the process industries lime is finding rapidly increasing and diversified applications. In the production of pectates, caseinates, tungstates, etc., new products and new fields are being opened up. In the "fine arts" we have such new and unique uses as illustrated by the lime spools for hair waving and in the food industry its application in the treating of egg albumen before drying, in the fillers for fireless cookers and the so-called chemical thermos bottles.

An example of the unexpected value of data of a more or less theoretical nature is found in a recent request for information as to a possible source of supply of hydrate of a certain exceptionally high specific gravity and apparent density. It happened that lime could be used in this process only if it possessed this particular density and it also happened that we could furnish just the information desired and thus saved the day.

Information on these physical properties such as particle size, apparent density and specific gravity is also necessary in considering the use of hydrate as a carrier for insecticidal dusts and our data has been used as a guide in tests conducted at a state experiment station on airplane and mechanical dusting for control of insect pests. The use of lime as an admixture and carrier for insecticides has increased rapidly, partially, we believe, owing to the proven uniformity of the material, but largely owing to the fact that specific data on its various properties are available. The warning of the probable increase of cotton boll weevil this year, recently issued by the department of agriculture, foreshadows a further increase this season in the demand for lime not only as an admixture but also as a raw material for calcium arsenate. (See Editor's note.) Preparations for tests on mosquito control by airplane dusting are also under way and opportunity will be offered for a first hand study of the physical requirements of lime for this purpose.

One of the rather interesting and important recent development in the technology of lime which we believe may largely be attributed to the far reaching effects of the research interest in lime is the publication for the first time, in the current edition of the Official Methods of the Association of Official Agricultural Chemists, of a section on (soil) liming materials.

In the course of all of this work which we have hurriedly surveyed and in all that completed and in progress, which we cannot mention separately, it has, of course, been necessary to devise and revise physical and analytical methods. Cooperation in the nature of comparative tests has been given the American Society for Testing Materials and some of the methods of lime analysis both physical and chemical will be published in the A. S. T. M. Proceedings.

As stated in previous annual reports, we consider the development of specifications for lime a very necessary activity and in this connection this year efforts have been made toward a concentration of this activity in Committee C-7 of the American Society for Testing Materials. The conservative attitude of this organization and its unquestioned recognition in the industries as the national sponsor for specifications for materials makes it the logical body through which to direct work. Through its representative membership of scientists and technologists, both producers and consumers, it also affords a most valuable and satisfactory medium for certain types of cooperative research. In the face of the increasing agitation and demand for specifications, the tendency has been and we believe will continue to be toward consolidation and unification with consequent reduction in actual number. A classification of uses is gradually being worked out on the basis of the functions of the lime and specifications applied accordingly. Progress along this line is slow however, owing to lack of information as to the relations between properties of the limes and the way they function. Here again we are called upon for more research data.

The digesting and cataloging of technical and scientific lime literature has continued as usual with the added activity involved in selecting and preparing material for the use of the Publicity Department.

The scientific, technical and trade periodicals carry in almost every issue articles of importance to all our interests. These contain data and information which should be used, and we conceive it as one of the duties of the Research Department to direct this material as such to the proper department, to members or to users or to abstract it and present it in a usable and easily assimilated form.

Through the membership letter the attention of the manufacturers is called to interesting articles and by means of the press releases of the Publicity Department and through the Agricultural Lime News Bulletin and direct correspondence the more important facts are given wide distribution. The response to most of these items has been quite favorable as indicating a genuine interest in this rejuvenated material, lime. The increasing requests from schools, colleges, universities and industrial and consulting laboratories for information and cooperation is exceedingly gratifying. The publication of a list of lime research problems in one of the journals of one of the scientific societies brought a large number of inquiries and requests for suggestions concerning cooperative research and as a result several new investigations have been started.

As concrete evidence not only of the success of such activities in arousing interest in lime but also as proof of the publicity value of a research organization may be cited the increasingly large number of articles which have appeared in the technical, scientific and trade journals during the year. The fellowships have yielded nine articles in different journals. The cooperative investigations have produced eight and there were sixty other articles not directly traceable to Association activities but nevertheless indicating the trend of interest.

The rapidly increasing use which is being made of this technical literature by lime manufacturers and salesmen and by users and investigators may be considered a favorable index of increased appreciation of lime, and the 50 per cent increase during the past year in the number of lime plants employing chemists indicates the increasing desire to improve products and to sell service. All such developments must necessarily elevate the plane of the industry and unquestionably react favorably upon both producer and consumer.

An article on Calcium Arsenate by John F. Blyth, appeared in the June 1, 1926, number of Pit and Quarry.—Editor.

CONSTRUCTION DEPENDS UPON LOCAL CONDITIONS LARGELY

The report of the F. W. Dodge Corporation of building contracts awarded in May brings out clearly the regional variations in the volume of production. Of the total contracts let in May, three-fifths were in the territory east of the Alleghenies and north of the Potomac, where business is largely of a financial and industrial character. Contracts let in the Central West were only 10 per cent of the total and less than one-half of the contracts let in New York State and New Jersey.

QUARRYING LIMESTONE FOR CEMENT MILLS

By F. A. Westbrook

LOCATED in the heart of the beautifully formed "Pennsylvania Dutch" district the limestone quarries and crushing plant of H. E. Millard at Annville, Pennsylvania, constitute a large and interesting operation for several reasons which will become apparent. There are two long quarries stretching out for a mile or more at the home plant. There are several others owned by Mr. Millard but they are too widely separated to be studied in one visit.

In one of these two home quarries there are three workings. At these the stone is picked by hand, loaded into cars and pulled up separate inclines by Ingersoll-Rand electrically driven hoists. The stone is dumped from the top of the hoister houses directly into freight cars. It is a high calcium stone and is sold almost exclusively to the cement mills. In fact supplying these mills constitutes the major portion of the business of the Millard operations. The other quarry supplies crushed stone also.

Drills at Work on Top of Quarry

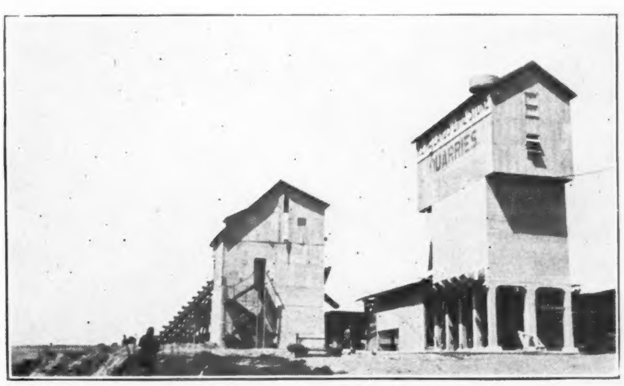
The lay out of machinery is rather unusual but apparently efficient, especially from the standpoint of mechanical handling. After blasting the stone is picked up by a Number 37 Marion electric shovel and placed in Gregg four yard side dump cars. These dump cars are hauled along the bottom of the quarry by a Whitcomb gasoline locomotive to the primary crusher located in the quarry. This is a McLanahan roll crusher. The stone is discharged into it by tipping the cars with a Number 1 Hanna Engineering Works six inch cylindrical air hoist.

Quarry for Cement Mill Stone

From the crusher the stone is carried on a Stevens 30 inch belt conveyor to a hopper or bin from which cars travelling on the incline to the surface are loaded. The incline has two tracks and the cars are pulled up by Ingersoll-Rand hoists and Roebling wire rope.

Quarry and Inclinee to Plant

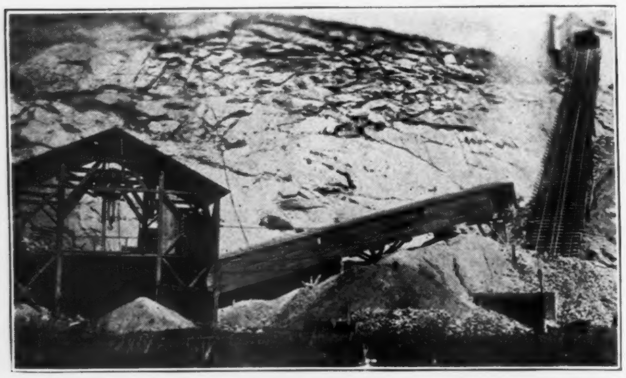
The design of the cars is according to Mr. Millard's own ideas. It is unusual but well adapted to the very steep grade. Instead of having the ends made so that they swing out for dumping purposes the upper end is left out. These cars are never used except on the incline and they are loaded at the open end while standing at the same angle. They are unloaded at the top by tipping up the lower end. The simplicity of the design, it will be appreciated, is very advantageous from the standpoint of eliminating parts which call for periodic repairs.



Hoist House at Left and Crushing Plant at Right

The incline and the hoister house is shown in one of the illustrations. Another picture shows the railroad tracks between the hoister house and the crushing plant. The stone which is dumped from the cars on the incline may be discharged into freight cars to be taken to cement plants or it may be discharged through a chute extending across the track to the secondary crusher. This crusher is also supplied with material from freight cars which bring it from other quarries belonging to Mr. Millard reached by the same railroad spur. The stone is dropped from the bottom of the freight cars in the same way as coal and a chute under the track guides it to the secondary crusher. Thus it will be seen that the arrangement is very flexible, as stone from the more distant quarries can be handled with the same facilities as that from the quarry immediately adjacent.

Delivering Stone at Primary Crusher



Primary Crusher and Belt Conveyor to Foot of Incline

Loading Platform to Roll Crusher

Top of Incline and Hoister House

The crushing plant consists of a Number 6 Kennedy gyratory gearless crusher. After crushing, the stone is elevated by a Kennedy elevator to a rotary screen of the same make which sorts it into the various standard sizes and drops each into a separate concrete bin. These bins, it will be seen from the illustrations, are so situated that motor trucks may be loaded from one side and freight cars from the other.

The plant is completely electrified in all departments and the machinery is practically all driven by Westinghouse motors. Perhaps the most unusual feature of the entire plant is the power house where the company generates its own power. The generator equipment consists of three turbo-alternate sets. These are:

Ridgeway turbine with 500 k.w. Ridgeway generator, Ridgeway turbine with 1,000 k.w. Ridgeway generator, Moore turbine with 150 k.w. Allis-Chalmers generator. The Ingersoll-Rand air compressors are located in the room with the generators.

Power is generated at 220 volts but that portion of it which has to be transmitted to the more distant quarries has the voltage stepped up by a bank of Pittsburgh transformers.

Steam for the turbines is supplied by three Heine boilers supplemented with a Cochrane feed water heater. Drilling is done by means of three Keystone drills, some of which are shown at work in the illustrations, and the quarries are kept dry by means of Cameron pumps.

In addition to the Number 37 Marion shovel already mentioned there are five others at the various points of operation around the Annville quarries. These include two Number 21 Marion, an Erie and two Thew shovels. One of these was observed at work stripping. Near the plant there are also five very attractively and neatly kept workmen's cottages. The office is in a small neat stucco building on the main highway.

ZIMMERMAN PASSES

The sudden death of Dr. Albert Zimmermann occurred on May 24th. Dr. Zimmermann was chief chemist for M. J. Breitenbach & Company of Brooklyn, New York. He had been a chemist for the Palmer Lime and Cement Company of York, Pennsylvania, and for E. R. Squibb & Sons. He was a member of the American Chemical Society.

PRODUCING SAND GRAVEL AT LOW COST

OREGON COMPANY DOES IT WITH THIS PLANT

By E. D. Roberts

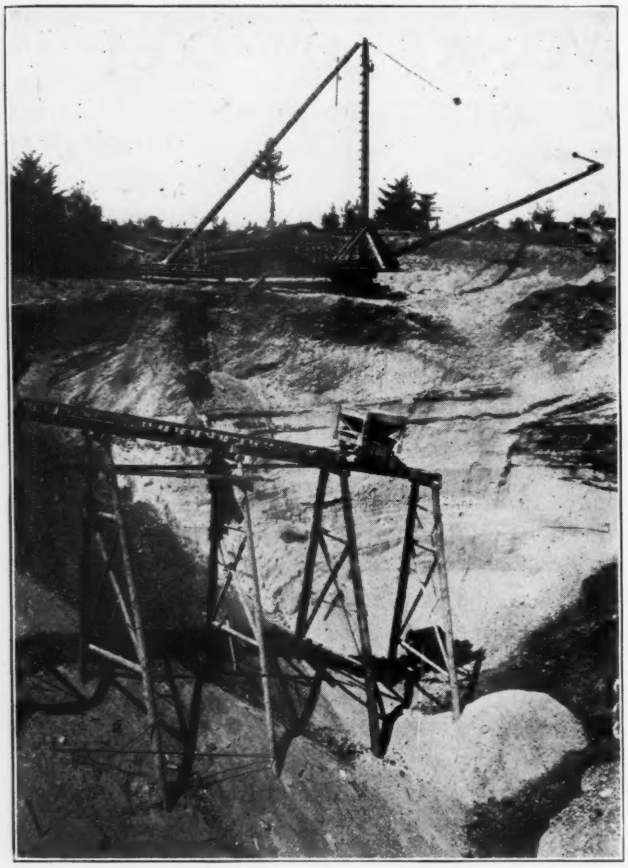
CONTRACTORS in and about Portland, Oregon, formerly used pit run materials for concrete. Large sections of this territory are underlaid with deposits of coarse sand and gravel that is remarkably clean. This material is of varying sizes and grades, but all that was necessary was to prospect a little and the desired sand and gravel could be found. The top material was scraped off and the wagons loaded directly by laborers shoveling from the original deposits. No attempt was made to grade the aggregate. It was used as it came, proportioned generally as a 1 to 6 mix. I have put in many a day as a boy loading the wagons or mixing it with cement and placing it as concrete.

Of course this is all changed now. The growth of the knowledge concerning the factors governing the strength of the concrete and the installation of modern methods have required that the materials be screened to enable the proper proportioning of the concrete mix and that all handling be done as cheaply as possible.

While paying a visit to my old home town, I happened to pass one of the pits in which I used to work so hard. Machinery had just been installed and they were starting to produce graded sand and gravel and crushed rock without apparent effort. It brought home to me the great labor saving possible by the installation of modern machinery. I used to work so hard with others to load a few yards of aggregate in a day and now it nearly "pours" out itself. A. F. Saar, operating under the name of the Portland Sand and Gravel Company, who owns this land is now producing material from this old pit. His plant and pit are located 6 miles east of the center of Portland, Oregon, in the residential district. He has had several machines installed that were made to his special order which has enabled him to produce marketable materials efficiently.

Before installing his plant, Mr. Saar had the tract thoroughly prospected disclosing that the deposit was of good material for 90 feet deep over the entire 7 acres and every indication shows that it continues to a much greater depth. The best ma-

The Pit of the Portland Sand and Gravel Company Located Six Miles from Center of Portland, Oregon



Method of Loading Cars from Pit by Derrick with Cars on Trestle

The Trestle Leading from Pit to Screening Plant and Storage Bins

terials are found around the 50 foot mark. However, the present operations are extending to the 70 foot level. After all the available material has been removed above this level, it is planned to lower the derrick and take out a second lift of 30 feet, which will carry the excavation to 100 feet below the ground level. The Smith and Watson Iron Works of Portland made a special hoist to operate the derrick excavator. This hoist has 4 drums mounted on one frame and is driven by a 75 h.p. Allis Chalmers motor. Two drums swing the derrick, another raises and lowers the boom and the fourth handles a 1½ yard Hayward clam shell bucket.

Picking up its load from a pit alongside the face, the bucket undermines the bank causing plenty of material to keep coming to the clamshell. The excavated material is lifted about 35 feet and dumped into a car resting on a trestle extending down into the pit. The car body is hoppered in shape with a capacity of 3 cubic yards. When full, it is drawn up the 25 per cent trestle incline to the bunkers by another Smith and Watson hoist operated by a 30 h.p. Allis Chalmers motor.

Bottom dumped from the hoppered car, the material falls into one of the two small bins which regulate the flow onto a grizzly which rejects all rock over 2 inches in size. Below the grizzly is a 48 inch by 10 foot revolving screen installed by the Phoenix Iron Works. This screen has ¾ inch and the other 1¼ inches, spray water onto the material as it enters the screen. After having served its purpose as a washing agent, the water is caught in troughs and carried to a 2,000-gallon settling tank from which a portion is reused for washing purposes and the balance used to carry off the sediment. A 3-inch centrifugal pump either returns the water for washing or pumps off the sediment as desired. The settling tank might seem to be superfluous but it saves considerably on the use of metered city water.

The material rejected by the grizzly falls into a number 9¾ Acme jaw crusher which reduces it to 2 inches or smaller. Another Allis Chalmers motor of 30 h.p. rating operates the jaw crusher. All material from the screen as well as that from the crusher is led by gravity to one of the ten compartments giving a bunkering capacity of 1,350 cubic yards.

The removal of the two or four feet of earth overlying the deposit or excessive washing to remove it from the excavated material is obviated due to a call for road gravel from the Multnomah county. When stripping seems necessary, the top is excavated by the clam shell bucket and mixed a few buckets at a time with the clean material from the pit. It is then handled like the regular pit run excepting that it is not screened and only enough water is added to cause it to run into the proper bin.

Looking Down Trestle Into Pit

This plan has turned out 300 cubic yards in a working day of 8 hours but is generally averaging a little better than 200 cubic yards, for the same period. Electricity for operation of motors is taken from the lines of the Portland Light and Power Company which furnishes electricity for power purposes at low rates depending upon the quantity consumed.

J. E. JELLICK PROMOTED

Mr. J. E. Jellick has been promoted to the position of manager of all the Pacific coast offices of the Portland Cement Association in charge of California, Arizona, Washington, Oregon, western and southwestern Nevada, northern Idaho and British Columbia, with headquarters at 785 Market Street, San Francisco. Mr. Amos H. Potts will take Mr. Jellick's former position as district engineer of the Los Angeles office, at 548 Spring Street. Mr. Jellick and Mr. Potts have had long experience in engineering projects and have rendered valuable service to the Association.

The Storage and Screening Plant Right on a Section Line Highway

A SMALL VETERAN PLANT

HENSEL'S Transfer, of New Philadelphia, Ohio, despite its name, is principally concerned with the production of sand and gravel and it is a veteran in the field having been in the business for 25 years. Naturally methods, prices, and standards have changed during the quarter of a century and Hensel's Transfer has kept pace with the times.

Clarence Hensel says he can remember the time when he believed he had done a good week's work in this branch of his business if he sold a dozen yards of sand. This was before concrete aggregate had come to the front and there was practically no market for gravel. It took considerable screening to get a yard of sand and in the early days this was done by hand.

At the start Mr. Hensel purchased a big gravel hill within the city limits of New Philadelphia. Gravel could be kicked up with the foot and consequently there was no stripping problem. He has dug away at this hill until it is now a pit. From dry bank the operation has changed to wet pit. The advent of concrete had a great deal to do with the change and the gravel which had been wasted became valuable and was sold at a good price. At first everything was pit run and as the deposit was naturally clean it met the standards of the early days.

The increased demand brought business competition and higher standards. This meant the building of a washing and screening plant which was only moderately successful because of the many repairs. After six years of operation this was abandoned and a new up-to-date plant was installed in the spring of 1923.

Bins with a capacity of 300 tons were built and a Sauerman drag line cable way with a half yard bucket was installed. A Tellsmith screening and washing outfit was purchased. The plant was sturdily built and the screens were placed in a house at the top of the bins. The new installation was greeted by an increased demand and for three months the plant was forced to run day and night to supply the trade. The method of operation is simple and efficient. The material is picked up by the bucket which operated in what remains of the hill and as deep as 30 feet under water in the pit. Water continually seeps in from the Tuscarawas River which runs near by.

The material is hoisted via the cable way to the inclosed screening plant where it is washed and dropped to the bins. When open storage is necessary a portable loader is used to load trucks. The concern specializes in supplying the local trade and all shipments are by truck. The plant is electrically operated, power being purchased from a local concern.

THERE IS NO SUBSTITUTE

By J. S. Elwell, Manager, Construction Department, National Lime Association*

TIME is indispensable in construction. It has always been used; it is used today and it will be used whenever and wherever economical and permanent building is done. The extent to which it is used will always depend on how generally and forcefully its advantages are kept before the public. Certain properties are universally accepted but many of the most important advantages of lime in the construction field are not fully appreciated.

Stucco, plaster, mortar and concrete are the general divisions of construction into which lime enters, and a few of its advantages in each will be briefly presented.

Stucco

Stucco is fundamentally a covering to conceal and protect whatever method of construction is used. It must be composed of materials which withstand all weather conditions, and the proof that lime stucco meets this requirement is its universal use. The excessively wet climate of England has not affected it in hundreds of years. Germany knew no other stucco in the past and does not today. In hot, dry Mexico lime stucco is used exclusively today just as it was generations ago. The long cold winters of New England do not bother the lime stucco that has stood there for many years.

Lime stucco is adaptable to any type of construction from the small house to the largest office building as demonstrated by its use on the Sesquicentennial buildings at Philadelphia and on the 14-story office building in San Francisco.

Also it is just as satisfactory on frame construction as it is on masonry; in fact it is often applied to both backings on the same building. On properly furred metal or wire lath lime will accommodate itself, to the inevitable settling and shrinking of frame buildings. The gradual hardening of lime over a considerable time avoids cracking on any acceptable construction.

The first or scratch coat is mixed somewhat rich in lime and with the proper amount of hair or fiber. It is applied as a heavy coat with sufficient pressure to give a firm key back of the lath. The pressure the plasterer must exert with lime stucco is less than with substitutes.

The first application is deeply scratched to give the best possible bond for the next coat. It is customary to allow the scratch to dry out for several days so that the stucco will develop its shrinkage and the building take the load. When all coats of a quick setting stucco are put on in quick succession the settlement caused by the weight of the stucco added to its shrinkage may cause unsightly cracks.

With lime the building is given time to gradually adjust itself while the three coats are being applied. There is no danger in rapid completion of a lime job after the first coat is partly set. The last two coats being light in weight and lean in cementing material are not subject to much shrinkage.

The addition of some gauging material is advocated and it may have some advantages, but many feel the use of too much will destroy the gradual adjustment of lime stucco.

The ease with which lime is worked is probably its best known property, and nowhere is this advantage more in evidence than in the stucco finishes. Any desired effect of color or texture is obtainable, and uniformity is assured for the plasterer is not hurried as when using a quick setting material.

In general, all large builders who have made a study of the economy and durability of stuccos are led straight to lime. This is true in Philadelphia, Columbus and Minneapolis and there is no reason why a more general understanding of the problem would not increase the field. Lime is the original stucco material and it is the best today, in spite of the many attempts to prove up substitutes by high pressure methods.

Plaster

No use of lime is more important than interior plastering. Everyone knows that lime is used for plaster, but few have any conception of the fundamental difference between plasters. The rust resisting, fire retarding and sound insulating properties of lime plaster have been swamped in the flood of propaganda that has been put out in the last 20 years.

Whether wood lath or metal lath are used, the durability of plaster is dependent on the action of that plaster on metal. If the metal lath or the nails in the wood lath are not protected from corrosion, the plaster is liable to failure and occupancy of a building may be actually hazardous.

It has long been known that lime prevents rust, and in recent tests run at the Rock Island Arsenal it was shown that corrosion was absolutely prevented by lime, while rusting had started on similar specimens exposed to air. Specimens tested in another commercial plaster were found to have "corrosion well developed."

Microphotographs show clearly that on the specimen exposed to moist air, rust had started to spread from the impurities in the steel. The surface of the metal tested in the other plaster was very dark and proves conclusively that this material attacks

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metal when moisture is present. It is well known that corrosion once started never stops. Under the same conditions lime prevented the start of corrosion and if it does not start it will never cause a failure in a ceiling.

It is very important that plaster be a fire retardant. Fire departments are given the right-of-way over all other traffic in order that they may get to the fire before it has had time to spread. If that fire can be confined inside the room where it starts just a few moments longer by some certain plaster, that plaster will prevent many serious fires. Few conflagrations spring forth full grown, for almost every fire is small at the start and it is only the ones that are not confined that are serious.

Many tests have been made with plasters under extreme fire conditions, but no comparative tests have been made to show their relative merits in the average starting fire. In—and perhaps thanks to—the absence of laboratory tests with the smaller fires, we must fall back on the practical experience of fire fighters for this information. Among the several fire chiefs that have stated their experience, Chief Alexander Henderson of Kansas City, Missouri, has best put their opinion, writing: "My experience has been that in buildings containing lime plaster, fires were more easily confined to their place of origin."

Next, consider acoustics. We have control over our eyes so that we need not see anything we wish to avoid, but our ears receive sounds whether we wish to hear them or not. This shortcoming makes it very important that our partitions be good insulators of sound.

The relative merits of different wall plasters in respect to sound are very difficult to fix. We can see two lights at the same time and easily tell which is the brightest, but we cannot be in two rooms at once and sense which is the quietest.

The fact that buildings plastered with lime plaster were quieter and more restful has long been known, but the full degree of difference between plasters has not been realized.

Recently, one phase of the problem of acoustics was investigated by the Bureau of Standards. Laboratory tests were made on many plasters to determine the extent to which sound would penetrate. Eight of the panels tested contained lime only and the tests show that in every case the transmission of sound was lowest with straight lime plaster.

In only three cases was direct comparison made between gypsum and lime and the results show that actual sound penetrates hard plasters with 6 to 24 times the volume that it penetrates lime plaster.

These figures are only a measure of the transmission of sound from one room to another. They do not touch on absorption and reflection which govern the acoustics within a room. The value of lime plaster in insuring a quiet room or building is well established by experience, but its importance has been over-shadowed in the intensive advertising campaigns of other plasters.

The application of lime plaster has been made to appear very difficult and expensive. This is due largely to the fact that the true facts regarding its use have been submerged. In reality lime plaster possesses advantages over all other plasters that justify many of the largest builders in the country in using it exclusively.

The detailed work of plastering with lime need not be discussed except to bring out the fact that the best of keys—on which the strength of all plaster depends—are obtained. Another fact with lime plaster which is not realized is that the brown may be immediately laid on the wall over the scratch coat.

Plastering a ceiling—where metal lath is now the standard—is a simple operation with lime. The scratch coat is put on rapidly and easily, and it is followed immediately with the brown coat. If properly haired absolutely no difficulty is experienced with plaster falling off.

Attention should be called to the choice of metal lath. It is always desirable to choose a lath that presents the greatest bearing surface for the plaster. The best lath is not always suitable for ceiling work. A certain lath may carry wall plaster perfectly, but when this same lath is put on a ceiling—the bearing surface may be so reduced that the plaster will not stay in place. A little thought and study of this detail will go far to improve plastering in general.

Passing up the usual involved arguments and falling back on practical experience, the simple facts remain that lime plaster does not destroy but rather preserves the metal that always holds it in place; it retards the spread of a fire, and insulates against sound better than any other plaster. The largest builders in the country use it for its economy, durability and ease of application. Lime plaster is suitable and also necessary for the finest work.

Mortar

The general public knows lime as something used to stick bricks together, and they are probably correct in that no brick or stone mortars are successfully used, unless they contain lime. In the struggle for business much pressure is brought to bear to show the necessity of adding something to lime mortar. On the other hand, certain patent mortars that advertise "no lime needed" are known to add the lime in their plant, which makes the advertisement true. It may be necessary to adulterate lime mortar to keep certain competitive industries solvent, but it is not necessary for the sake of the mortar itself.

Independence Hall—over 150 years old—tells the story of durability just as well as going back to Babylon. The question of strength required is answered by considering that any modern house or apartment seldom has walls over five stories high. Modern office buildings, with their great height, do not depend on their masonry for strength, but rather carry their walls story by story on steel or concrete frames.

Even at the age of one day, tests at the Rock Island Arsenal prove that lime mortar does not show appreciable settlement at loads far above anything met in practice.

The principal material added to lime mortar is portland cement, which adds unnecessary strength at the same time that it cuts down the workability. A little study of this question will reveal an increase of cost as cement is added that is out of all proportion to even the laboratory results obtained. In practice this unnecessary strength is seldom obtained because of poorer workmanship and also to the fact that the cement has probably hardened before it gets into the wall. Lime-cement mortars are satisfactory in spite of rather than on account of the added material. Even cement advocates admit that lime is required in all mortar as their specifications for straight cement mortar includes a certain percentage of lime to make it workable; or in other words, the lime is added to make it mortar.

As an example, The West Baden Springs Hotel boasts of the largest dome in the world, with a span of 200 feet, or 12 feet larger than St. Peter's Cathedral in Rome. This dome supported on 16 brick piers is laid up in straight lime mortar without any added cement.

Such examples of the use of lime mortar are scattered throughout this entire country. One and all these structures demonstrate beyond a doubt that lime mortar is all that a mortar should be. A general knowledge of the truth, the whole truth and nothing but the truth about straight lime mortar, would result in the saving of millions of dollars in the construction industry.

Concrete

The fact that lime is added to concrete by the biggest men in the construction industry is bound to raise the question as to why they do it.

Colonel Cooper specified its use in the Wilson Dam at Muscle Shoals, and it is specified in all Government work under the direction of the Chief of Engineers, U. S. Army. There is good and sufficient reason why such men insist that concrete on which they stake their reputations shall be as good in the forms as it came out of the mixer. Lime acts as a lubricant, facilitating placing and at the same time preventing the stone and grout from becoming unmixed on the trip from the mixer to the form. It insures an easier placed and more uniform concrete, which accounts for the watertightness and the greater strength of lime concrete.

Caution says that "lime does not weaken concrete," but that is only a small part of the story. Structural or building concrete is generally difficult to work into the forms on account of small sections and heavy or complex reinforcing. Workability, or the ability of concrete to be worked into place, is obtained by adding either water or lime. Excess water reduces the strength while lime does not. It follows logically that if the required workability is obtained by lime and the amount of excess water is reduced, the concrete will be stronger. Field specimens prove that the use of lime does result in stronger structural concrete and friends of lime need not apologize for that fact.

The greater uniformity of concrete placed by the lime method is the direct and logical result of being able to move the concrete into place in the same condition that it left the mixer. Here again the specimens taken from jobs justify the use of lime because the designer is sure that there is no weak concrete at the critical points. The improved appearance of lime concrete is also the result of its uniformity and workability.

We would naturally expect that the Chicago Plan Commission would use the most economical and dependable method of watertightening the pits of their bridges over the Chicago River. Their letter on the subject says: "Ten pounds of hydrated lime per bag of cement was specified and used. The counterweight pits of all these bridges have proven to be absolutely watertight." At the Wells Street Bridge it is 34 feet from the water line to the bottom of the pits and they tell us these pits are absolutely dry. There is no mysterious property in lime that watertightens concrete, it is just that uniform, dense concrete is watertight.

All concrete, and even good concrete, will in time weather or disintegrate. Considerable study has been put on this subject in the last few years, and it has been found that temperature and moisture changes are the major causes. Investigations have shown that the stresses due to alternate wetting and drying may be five or six times as great as the greatest temperature stresses. Professor H. A. LaRue of Missouri University has stated that the moisture stresses in concrete are reduced to one-twelfth or over one-twentieth, by the use of lime. Considering that these two forces may act in the same or opposite directions, it can be demonstrated that the tendency to disintegration with lime is only 12 to 25 per cent of what it is in plain concrete. If we take frost action into consideration the advantage of lime concrete is greater than ever.

Concrete products are materially improved by lime. Recent plant-runs that were tested at the Rock Island Arsenal prove that the addition of 20 per cent or more of lime makes concrete blocks watertight, as well as stronger. Cinder blocks are manufactured cheaper and better with lime. Precast products of all kinds are cleaner, truer and more marketable.

HYDRAULIC CEMENTS FROM COPPER SLAGS THE RESULTS OF AN INVESTIGATION

By G. Agde and P. Assmann

DURING the War a process was developed for the recovery of copper from scrap metals containing copper alloys. Large amounts of slags were produced, the utilization of which was economically desirable. The scrap metal was separated into coarse and fine. The fines were agglomerated with roasted copper pyrites and culm in the Dwight-Lloyd sintering machine, united with the coarser material and melted with the slag resulting from its own refining in a water jacket furnace. Varying amounts of lime and iron were added and black copper was obtained. The slags produced had formerly been carried to slag dumps. The obvious idea of using these slags for producing hydraulic cements had been laid aside—without careful testing—because they contained besides the hydraulic factors, varying amounts of impurities such as copper oxide (cuprous oxide), zinc oxide, ferrous oxide and phosphoric anhydride which would deleteriously affect any such use.

This article presents the results of an investigation of these problems. Most successful of all was the attempt to use these copper slags on the basis of their content of iron oxide compounds as a natural cement. These investigations showed not only that from these slags a cement of standard properties could be prepared, but also that especially valuable products could be obtained in that the cements produced in some cases exceeded the standard strength values and even in some cases showed a compression value after three days which exceeded that fixed by the standard specifications.

Points of View for Utilization

The following is clear from the analytical figures:

1. The high content of silicic acid and the low content of lime, irrespective of the unusual ratio of these factors to the alumina and iron oxide content, render any direct utilization either as slag-cement or as blast-furnace cement impossible.

2. On account of the ferrous oxide content the utilization of the slag to form a hydraulic cement is to be considered only if the ferrous oxide can be quantitatively oxidized to ferric oxide; this is possible in the case of sintered cements and can be accomplished by the usual technical production processes. The high iron content indicates its special utilization as a natural cement.

3. Even if success was obtained in enriching the slag with lime to form a hydraulic cement in composition and to oxidize the ferrous oxide to ferric oxide, even in the case that the slag could be used simply as the silicous and alumina and iron oxide components for the preparation of a portland cement or a natural cement, the effects of the impurities copper oxide or cuprous oxide, zinc oxide and phosphoric acid were not known nor could they be foretold so that a special investigation of this problem became necessary.

Translated from Zeitschrift für Angewandte Chemie, exclusively for Pit and Quarry, by Abert P. Sachs.

Description of the Slags

The slags used for this investigation were obtained from Kupferhütte Trotha A. G. (Trotha Copper Refineries, Inc.). They had a vitreous structure and a greenish-black color with a brownish cast. It was completely soluble in muriatic acid. The following components were found on analysis:

	Per cent	Acid Oxygen	Basic Oxygen
SiO_2	92.43	22.60	....
P_2O_5	1.06	0.59	....
S	1.43	.....	....
CuO	1.05	.....	0.21
PbO	0.35	.....	0.03
SnO_2	0.40	.....	0.09
FeO	13.20	.....	2.94
Fe_2O_3	1.73	.....	0.52
Al_2O_3	3.20	.....	1.51
ZnO	5.64	.....	1.11
CaO	23.45	.....	6.70
MgO	3.75	.....	1.49
K_2O+Na_2O	0.72	.....	....
		23.19	14.80

The silicification degree is obtained from the formula:

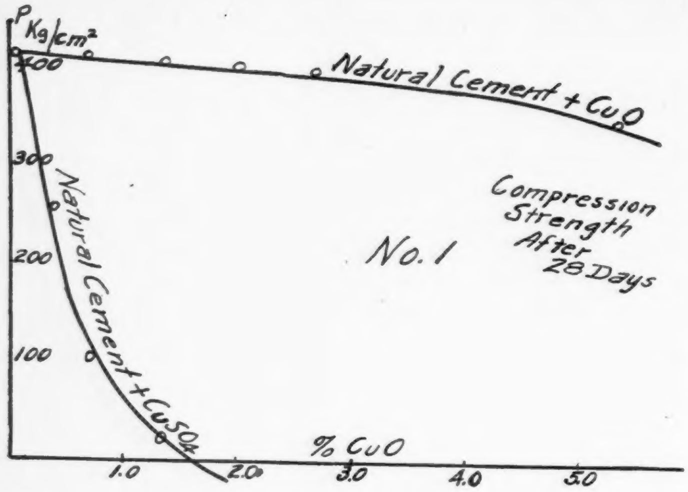
$$\frac{\text{Acid Oxygen}}{\text{Basic Oxygen}} = \frac{23.19}{14.80} = \frac{3}{2};$$

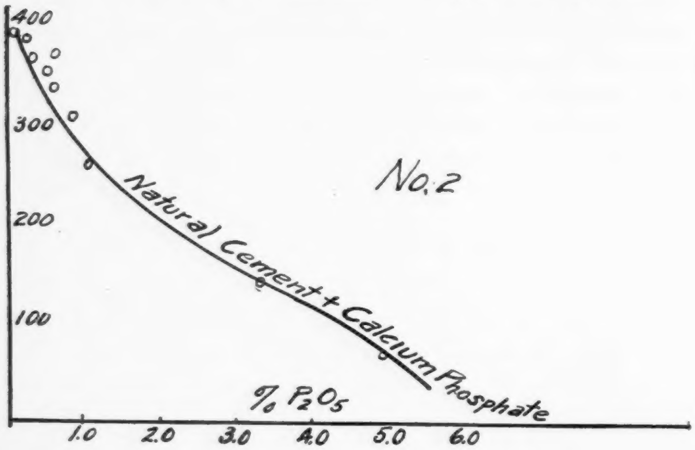
(in which aluminum oxide and iron oxide are considered as bases).

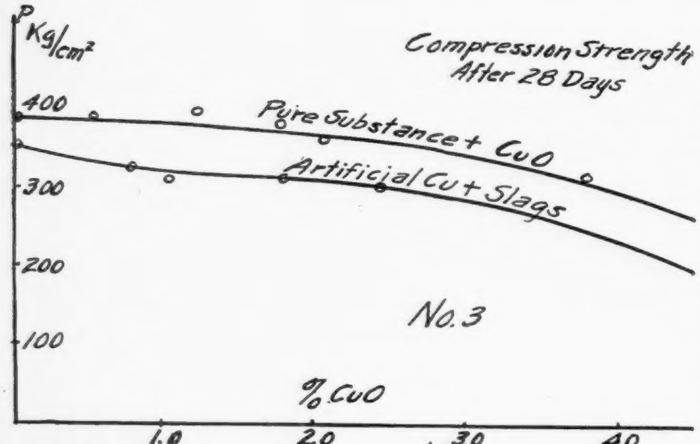
We have therefore a sequi-silicate which is confirmed by the difficult fusibility, high viscosity of the melt and the vitreous structure.

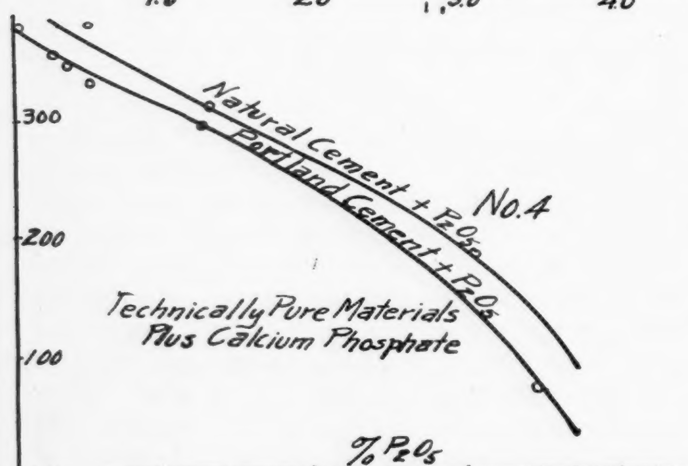
Preparation of Natural Cements

If the slag analyzed above is considered from the viewpoint of a raw material for the production of sintered cement, we see, as was previously mentioned, that it is best suited to form a natural cement, as it contains the two components necessary for the purpose, namely, silica and alumina + iron oxide, while only the lime content is too low. Therefore, in order to produce natural cement from the slag it is necessary only to admix the required amount of lime, to submit the mix to a normal oxidizing sintering process and finally to determine how the impurities present in the slag affect the finished cement. For this purpose numerous cements were prepared, the raw mixtures being continuously varied as to silicate modulus and hydraulic modulus by the addition of powdered slaked lime. The silicate modulus M_s was varied









from a maximum value of 4.0 to a minimum of 1.2 and for each of these values of M_s 3-5 raw mixtures with various hydraulic moduli M_h were prepared with values between 2.0 and 1.2.

The calculation of the raw charge was carried out as follows:

Given M_s and M_{ht}

Desired SiO_2, R_2O_3 ($=Al_2O_3 + Fe_2O_3$), and CaO in %

$$M_s = \frac{SiO_2}{R_2O_3}$$

$$M_h = \frac{SiO_2}{SiO_2 + R_2O_3}$$

$$100 = (SiO_2, R_2O_3 + CaO)\ \%$$

The solution of this system of equations for the three unknowns (SiO_2, R_2O_3, CaO) gives:

$$SiO_2 = \frac{100M_s}{(M_h + 1)\ (M_s + 1)}$$

$$R_2O_3 = \frac{100}{(M_h + 1)\ (M_s + 1)}$$

$$CaO = \frac{100M_h}{(M_h + 1)}$$

A fundamental condition for successful burning was found by a preliminary test to be the preparation of as homogenous a raw material mixture as possible. Bricks prepared from the raw material by the so-called thick-lime process were dried and burned in the laboratory gas-fired shaft furnace. The necessary temperature as determined by a Wanner pyrometer was in no case higher than 1,350° C. The cause for this relatively low burning temperature is to be found in the fact that on the one hand these cements contain less lime than normal portland cements and on the other that the slags and also the admixed slaked lime have their lime in a more reactive form than the limestone generally used in practice. The temperature was slowly raised during the burning and the air supply was so regulated as to be always in slight excess so that oxidation of the iron might occur. Only during the last few minutes of the calcination was the process carried out with a slight excess of gas in order to obtain the highest possible temperature in the furnace without any excess of air. Only in this way were useful natural cements obtained. The clinkers with the highest silicate moduli showed "dripping" but this could be prevented by rapid cooling of the product. Sometimes only the overburned portions of the clinker were subject to "dripping" but at other times also the underburned parts. Analyses of clinker showed that the zinc oxide present in the slag was chiefly distilled out during the burning. A small portion of the ferrous oxide was also volatilized by the burning.

The normally burned clinker had a dull dark gray to black-green appearance, the under-burned clinker was light gray to gray-brown and the over-burned material was lustrous black. The pulverized cement was throughout of a gray-brown color like that of the natural cement produced by the Hemmoor Portland Cement Works. The over-burned clinker always exhibited a behavior differing from that of the fused cements even when both had the same composition analytically. For example, the fused cements "dripped" in all cases and hardened but very little or not at all; the over-burned clinker did not "drip" in all cases and always exhibited hydraulic properties even when fused cements of the same composition had no hydraulic properties at all. This completely confirms the more recent ideas on the phenomena of fused cements.

The 43 products prepared are arranged according to composition and properties in the accompanying table. The moduli calculated from the analyses determined the arrangement; the order is that of decreasing silicate modulus M_s; in addition for each constant average value of M_s the cements are arranged in groups according to increasing values of the hydraulic modulus M_h.

In considering the composition of the cements prepared the characteristic feature of natural cements appears, namely the lower lime value than for portland cements. The copper oxide and phosphoric acid values to be considered later have approximately the value in the cement that calculation from the composition of the charge would require. The analyses gave higher values than calculated for magnesium oxide, alumina and sulfur, chiefly due to contamination of the clinker, by the furnace lining, etc.; however, these slight impurities are inconsequential in estimating the value of the cement. The burned clinker had lower values for iron oxide and zinc oxide than the raw mix, the iron oxide being diminished by a few per cent and the zinc oxide by 80-90% of the amount present originally.

Compression Strengths

The compression strengths were determined after 3, 7, and 28 days—each 1 day in moist air and respectively 2, 6 and 27 days in water—from mortar test pieces of a 1:3 ratio. They exhibit a certain regularity.

For a given silicate modulus M_s and increasing hydraulic modulus M_h the 28-day compression

						Setting Time		Composition					
Nr.	M_s	M_h	P_3	P_7	P_{28}	Start	Finish	SiO_2	$Fe_2O_3+Al_2O_3$	CaO	CuO	P_2O_5	Remarks
1	4,2	1,75	13	40	64	3¼ h	4¼ h	27,23	6,35	59,45	0,61	0,65	"dripped"
2	3,9	1,78	18	40	80	over	24 h	25,33	6,16	56,50	0,58	0,63	
3	4,0	1,92	18	44	91	over	24 h	24,53	6,13	60,00	0,50	0,60	"dripped"
4	3,8	1,30	16	30	68	4 h	5 h	27,44	7,25	46,28	0,60	0,63	
5	3,7	1,50	24	48	132	4½ h	6 h	26,30	7,10	51,20	0,50	0,60	partially "dripped"
6	3,7	1,63	10	54	159	over	12 h	25,74	6,90	53,20	0,55	0,60	
7	3,4	1,23	30	58	116	3 h	4½ h	27,67	8,17	44,00	0,64	0,55	
8	3,5	1,57	61	80	231	over	24 h	26,52	7,63	51,23	0,63	0,52	
9	3,4	2,05	58	91	278	over	12 h	22,00	6,52	58,53	0,55	0,50	resists cooking test
10	2,9	1,21	26	61	92	4 h	5½ h	28,03	9,18	45,75	0,72	0,68	
11	2,9	1,39	58	86	144	3½ h	4½ h	27,32	9,35	51,30	0,65	0,62	
12	2,9	1,57	54	116	194	2¼ h	2½ h	25,55	8,72	58,80	0,58	0,58	
13	2,9	1,67	91	130	212	1 h	3½ h	23,85	8,34	54,63	0,55	0,52	
14	2,8	1,54	24	44	118	over	8 h	23,81	8,52	50,22	0,55	0,46	
15	2,7	1,81	96	178	265	2¼ h	4 h	22,72	8,33	56,22	0,51	0,53	
16	2,8	2,07	90	146	288	1 h	2¼ h	22,35	8,12	61,50	0,51	0,45	
17	2,6	1,34	36	116	150	2 h	6 h	26,00	10,15	48,41	0,54	0,49	
18	2,5	1,56	32	118	188	1 h	3½ h	23,00	9,51	51,62	0,50	0,52	
19	2,5	1,65	58	118	198	2 h	3½ h	24,29	9,65	55,81	0,48	0,53	
20	2,4	1,47	64	119	162	1 h	3 h	24,84	10,35	52,00	0,58	0,58	
21	2,4	1,65	112	181	277	3¼ h	5½ h	22,30	9,22	51,85	0,50	0,52	
22	2,4	1,98	138	218	372	3½ h	5 h	20,27	8,46	57,40	0,47	0,50	
23	2,3	1,29	49	79	95	2½ h	4¼ h	26,59	11,59	49,28	0,54	0,50	
24	2,3	1,50	70	102	131	3 h	6¼ h	24,03	10,05	52,08	0,54	0,52	partially "dripped"
25	2,3	1,68	82	142	187	1½ h	3 h	23,60	10,21	58,60	0,53	0,57	
26	2,3	1,81	183	245	295	2¼ h	3½ h	21,94	9,48	56,61	0,50	0,43	
27	2,2	1,45	61	81	80	5 h	8½ h	25,60	11,68	54,00	0,52	0,45	
28	2,2	1,78	72	121	178	1½ h	4 h	21,00	9,74	54,60	0,42	0,50	
29	2,1	1,32	45	72	72	½ h	2 h	25,00	11,92	51,42	0,53	0,53	
30	2,1	1,56	60	100	164	1½ h	3 h	22,58	10,82	52,11	0,51	0,43	
31	2,1	1,75	89	146	188	1½ h	5½ h	22,71	10,36	55,92	0,50	0,50	
32	2,0	1,47	130	230	276	2 h	6 h	23,70	11,78	52,31	0,53	0,53	
33	2,0	1,62	179	325	418	2¼ h	3 h	25,30	12,78	61,92	0,52	0,43	
34	2,0	1,71	240	358	448	1¼ h	3¼ h	24,58	12,28	62,80	0,53	0,50	resists cooking test
35	1,9	1,53	84	103	108	1¼ h	5 h	24,01	12,40	51,92	0,56	0,55	
36	1,9	1,65	152	240	293	2 h	3 h	22,11	11,57	53,93	0,50	0,48	
37	1,9	1,90	205	339	455	½ h	4¼ h	20,27	10,71	59,00	0,48	0,46	resists cooking test
38	1,8	1,26	71	95	105	¾ h	2 h	25,79	14,30	51,49	0,55	0,56	
39	1,8	1,55	130	202	220	1¼ h	2 h	22,32	12,42	54,00	0,53	0,42	resists cooking test
40	1,8	1,61	130	191	256	1¼ h	4 h	22,10	13.15	56,71	0,48	0,42	
41	1,8	1,90	141	220	293	½ h	2½ h	19,95	11,05	64,00	0,46	0,48	
42	1,4	1,51	148	210	178	¾ h	5 h	25,78	14,31	58,05	0,48	0,49	fails on cooking test
43	1,3	1,78	270	278	280	¼ h	3 h	19,95	15,30	63,20	0,40	0,43	fails on cooking test

$$M_s = \frac{SiO_2}{Fe_2O_3+Al_2O_3};$$

$$M_h = \frac{CaO}{SiO_2+Fe_2O_3+Al_2O_3};$$

P_3 = Compression Values of Mortar 1:3 after 3 days
P_7 = Compression Values of Mortar 1:3 after 7 days
P_{28} = Compression Values of Mortar 1:3 after 28 days

strength value increases appreciably, most strongly for $M_s = 2.0$ and $M_s = 1.9$; the three day and seven day strengths also generally increase.

Only with very high solicate moduli is this rise in compression strength with increasing hydraulic modulus not present without exception. In some cases the three-day compression strength actually decreases with increasing lime content, that is to say the rise in compression strength of the individual cement appears only after aging for more than three days (cements number 4-8).

In other cases certain irregularities appear in the curves as for instance in the three day strengths for which in the case of relatively high silicate moduli this strength value shows a deviation, that is to say, does not increase as expected with rising M_h (Cement no. 12).

Also, for a low silicate modulus similar irregularities occur (cement no. 40).

An important anomaly occurs in cement no. 42 in which the seven day strength is higher than the twenty-eight day value; the product has diminished in strength by exposure to water for more than 7 days.

The highest compression values were exhibited by the products with $M_s = 2.0$ and 1.9 (cements no. 32-37).

More important than this consideration with respect to rising hydraulic moduli is that based on time for hardening.

For products with the largest silicate moduli, up to about $M_s = 3.4$ (cements no. 1-9) the compression strength increases with time almost linearly to a maximum value. The property expected of a good cement that after seven days it should possess about two-thirds of the compression strength acquired in twenty-eight days is fulfilled approximately only in certain cases (cements no. 4-13).

Better values with respect to compression strengths are shown by the following cements with $M_s = 2.2$ (cement no. 28). In most cases the specified requirement is met that the seven day strength be about two-thirds of the twenty-eight day value. The best properties are shown by the cements with a still lower M_s. The twenty eight day compression strengths in certain cases reach values far in excess of the standard value of 200 kg/cm^2 (cements no. 34, 37); in almost all cases the seven day compression strength approaches that required for 28 days and in some cases the standard strength values are reached in three days (cements no. 34, 37). The most valuable cements are those which reach their highest compression strengths in the shortest possible time.

The last cements ($M_s = 1.8$) finally show certain irregularities, which make them partially unsuitable for practical use.

A comparison of the compression strengths obtained with the content of phosphoric anhydride shows certain regularities in that cements with more than 0.6% phosphoric anhydride exhibit no high compression strength values.

Setting Times

The time of setting shows no recognizable regularities. However, it is to be seen that the cements high in iron oxide are better binding materials with respect to setting time and strength than cements high in alumina.

Addition of Gypsum

Addition of gypsum caused a decrease in the time of setting, while the start of the setting period was delayed.

ADDITION OF 3 PER CENT GYPSUM

No.	P_{28}	Setting Time Start	Setting Time Finish	No.	P_{28}	Setting Time. Start	Setting Time. Finish
20	162	1½ hrs.	2¼ hrs.	25	178	2 hrs.	2¾ hrs.
21	281	6 hrs.	6½ hrs.	26	270	2½ hrs.	3 hrs.
22	374	2 hrs.	2½ hrs.	29	80	1 hr.	1¼ hrs.
23	102	2¾ hrs.	3½ hrs.	30	172	1¾ hrs.	2¼ hrs.
24	143	4 hrs.	4¼ hrs.	31	211	3½ hrs.	4¼ hrs.

The numbers in column 1 refer to the complete table.

In considering the strength figures in this table we find in some cases a small increase over cements containing no gypsum.

Cooking Tests

Individual cements were subjected to and survived the cooking test. The cements last prepared ($M_s = 1.8$) however, showed blow phenomena.

Influence of Impurities

There still remained the second part of the problem to be solved, namely, the determination of the influence of impurities contained in the original slag. These are chiefly cupric or cuprous oxide, zinc oxide, phosphoric anhydride. The literature gives no disclosure as to the effect of these foreign substances in cement; however, for a long time there has been the unproved assumption among cement technologists that these foreign substances diminish the value of the cement.

Zinc Oxide

Investigation of the influence of zinc oxide on cements was superfluous as this substance is volatilized during the burning; this would also always be the case in burning the cement in technical shaft furnaces or rotary kilns.

Copper Sulfate, Copper Oxides

The influence of cupric oxide or cuprous oxide was studied in four series of experiments. Owing to the presence of sulfur in the slag the formation of copper sulfate in the presence of smaller amounts of lime was possible so that the natural cement was mixed with increasing amounts of copper sulfate and subjected to hardening tests.

1. Mixtures with Copper Sulfate
Compare Fig. 1

No.	Cu %	CuO %	CuSo₄. Sh₂O	P_{28}	Setting Time Start	Finish
0	0.00	0.00	0.00	420	4½ hours	6½ hours
1	0.25	0.32	0.98	250	6½ "	12 hours
2	0.50	0.63	1.96	110	more than	12 hours
3	1.00	1.25	3.93	30	more than	24 hours
4	1.50	1.88	5.89	...	....	....
5	2.00	2.50	7.86	...	....	....

The 28 day strength tests showed a sharp decrease with increasing percentages of copper sulfate. More than 4% copper sulfate prevents all hardening. This effect of copper sulfate is surely due more to the sulfate ion than to the copper ion.

In addition mixtures of natural cement with increasing amounts of copper oxide were prepared and setting time and compression strength similarly determined.

2. Mixtures with Copper Oxide (Compare with Figure)

No.	Cu %	CuO %	P_{28}	Setting Time Start	Setting Time Finish
0	0.00	0.00	420	4½ hours	6½ hours
1	0.50	0.63	420	4½ "	7 "
2	1.00	1.25	410	5 "	7 "
3	1.50	1.88	400	5 "	8 "
4	2.00	2.50	400	5½ "	8 "
5	3.00	3.75	396	5½ "	7½ "
6	5.00	6.25	370	6 "	8 "

From this series of tests it seems to be proved that the assumption is justified that copper oxide in small amounts such as occur in copper slags produce no deleterious effects on the cements burned from these slags.

3. Charges with Copper Oxide (Technically Pure Materials)

No.	Cu %	CuO %	P_{28}	Setting Time Start	Setting Time Finish
0	0.00	0.00	380	6 hours	8½ hours
1	0.50	0.63	380	3¼ "	4 "
2	1.00	1.25	400	1¼ "	4 "
3	1.50	1.88	382	2½ "	3 "
4	2.00	2.50	352	4 "	5¼ "
5	3.00	3.75	323	2 "	3¼ "
6	5.00	6.26	240	4 "	5¼ "

Analyses SiO_2	R_2O_3	CaO	CuO	M_s (approx. const.)	M_h (approx. const.)
22.62	10.10	64.15	0.00	2.2	1.97
22.31	11.20	63.32	0.53	2.0	1.84
21.02	11.05	62.05	1.20	1.9	1.94
22.35	9.43	61.87	1.73	2.1	1.94
21.87	10.95	62.80	2.03	2.0	1.95
21.53	10.78	63.08	3.85	2.0	1.96
21.00	11.05	61.75	5.93	2.0	1.92

From this it appears that with increasing copper oxide content the setting time is increased somewhat but the 28 day strength values decrease but little, and then only if appreciable quantities of copper oxide act as a diluent of the cement.

The same results with respect to strength were obtained from the other two series of tests in which cements were prepared by burning to the sintering point in the one case pure substances with copper oxide and in the other slags with varying contents of copper oxide.

As the tables show the observed setting times do not differ greatly from those for normal cements (i. e. without copper oxide).

The strength values first show small decreases with considerable amounts of copper oxide as copper oxide then functions as a foreign material.

4. Charges with Slags Containing Copper Oxdie

No.	Cu %	CuO %	P_{28}	Setting Time Start	Setting Time Finish
0	0.00	0.00	362	4¼ hours	8½ hours
1	0.50	0.63	323	2½ "	4⅓ "
2	1.00	1.25	305	3¾ "	5½ "
3	1.50	1.88	312	4¾ "	8½ "
4	2.00	2.50	300	3¾ "	4¾ "
5	3.00	3.75	253	4¾ "	6½ "
6	5.00	6.26	208	5 "	8 "

Analyses SiO_2	R_2O_3	CaO	CuO	M_s (approx. const.)	M_h (approx. const.)
22.30	10.87	66.35	0.00	2.1	2.00
23.35	12.36	63.85	0.78	1.9	1.84
22.56	9.53	63.05	1.00	2.2	1.97
21.80	10.85	62.82	1.72	2.0	1.92
20.36	10.95	61.30	2.32	1.9	1.95
21.73	11.56	62.83	3.26	1.9	1.88
21.84	9.83	61.42	6.78	2.2	1.93

Phosphoric Anhydride

Analogously to the above the effect of phosphoric anhydride was determined by three series of tests.

The series of mixtures of natural cements with increasing amounts of tricalcium phosphate shows an increase in setting time as compared to the pure natural cement and in addition an important diminuation in compression strength for contents of phosphoric anhydride exceeding 0.6%.

1. Mixtures of Natural Cement with Calcium Phosphate

No.	P_2O_5 %	$Ca_3(PO_4)_2$ %	P_{28}	Setting Time Start	Setting Time Finish
0	0.00	0.00	390	4½ hours	6½ hours
1	0.10	0.22	390	4 "	5½ "
2	0.30	0.65	370	5 "	8½ "
3	0.60	1.31	370	5 "	6½ "
4	1.00	2.20	250	8 "	10 "
5	3.30	7.41	150	8 "	12 "
6	4.80	11.12	100	above	24 "
7	9.00	19.60	70	above	24 "

An increasing diminuation in strength values with increase in phosphoric anhydride appears in both series of tests in which one consisted of portland cement raw materials and the other of natural cement raw materials burned with varying amounts of tricalcium phosphate.

Natural cement shows the better behavior in this case. The setting times are decreased in both cases without any recognizable regularities.

Perhaps this behavior of phosphoric anhydride can be chemically explained by assuming that at first the silica liberates phosphoric acid. The free phosphoric acid can then unite with the free lime, but by interaction with the aluminum or iron ion may cause further decompositions in the clinker complex which on treatment with water as the finished cement prevent normal setting and hardening as a result of solution and dissociation phenomena.

2. Portland Cement Raw Materials (Compare Figure)

No.	P_2O_5 %	$Ca_3(PO_4)_2$ %	P_{28}	Setting Time Start	Setting Time Finish
0	0.00	0.00	381	3½ hours	4¾ hours
1	0.20	0.44	356	1¼ "	1½ "
2	0.30	0.65	343	1¼ "	1½ "
3	0.60	1.31	330	1½ "	1¾ "
4	1.00	2.20	300	¼ "	½ "
5	3.30	7.41	80	¼ "	1 "

Analyses SiO_2	R_2O_3	CaO	P_2O_5	M_s (approx. const.)	M_h (approx. const.)
20.35	9.36	68.20	0.00	2.2	2.31
20.87	10.86	65.20	0.25	1.9	2.06
21.56	11.53	64.30	0.28	1.9	1.95
21.30	9.83	64.03	0.53	2.2	2.06
23.05	9.72	64.82	1.20	2.2	1.97
22.12	10.32	63.32	3.52	2.1	1.95

3. Natural Cement Raw Materials ($Fe_2 : Al_2O_3 = 3 : 1$)

No.	P_2O_5 %	$Ca_3(PO_4)_2$ %	P_{28}	Setting Time Start	Setting Time Finish
0	0.00	0.00	400	4½ hours	5½ hours
1	0.20	0.44	380	1½ "	1¾ "
2	0.30	0.65	390	1½ "	1¾ "
3	0.60	1.31	376	1¾ "	1 "
4	1.00	2.20	310	½ "	1 "
5	3.30	7.41	176	1 "	1½ "

Analyses SiO_2	R_2O_3	CaO	P_2O_5	M_s (approx. const.)	M_h (approx. const.)
20.89	11.05	60.04	0.00	1.9	1.87
22.36	10.89	61.03	0.32	2.0	1.84
23.52	9.00	60.32	0.36	2.6	1.86
20.83	11.83	59.20	0.43	1.8	1.82
21.32	9.98	62.83	1.28	2.1	1.93
20.82	12.32	57.32	3.12	1.7	1.76

From the tests which we have described and the results therefrom the problem of the rational utilization of the slag in question to produce a serviceable cement is solved on the laboratory scale. The limits have been determined which the impurities must exceed, especially phosphoric anhydride, to yield serviceable cements.

Summary

Experiments have been described for the production of hydraulic cements from slags resulting from the reworking of old copper alloys.

1. The production of a high grade natural cement is possible by using an ordinary oxidizing sintering. The calculation of mixtures to obtain desired moduli is possible without additional difficulties as the bases in the slags are not in equilibrium with atmospheric oxygen at the high temperatures reached. Consequently the empirical method of determining the best compositions is available.

2. The cupric oxide or cuprous oxide present in the slags does not adversely affect the strength values of the cement.

3. The phosphates present in varying amounts in the slags may affect the strength very adversely if present in amounts exceeding 0.6% as phosphoric anhydride.

4. Portland cement with a content of more than 0.6% phosphoric anhydrided exhibits blow phenomena in contradistinction to natural cement.

5. By adding 3% of gypsum the setting time of the natural cements produced from the slags can be so altered as to delay the beginning of setting while shortening the total setting time.

SUCCESS WHERE ANOTHER FAILED

BUSINESS upsets to another tumbled a stone quarry into the lap of C. A. Starkweather, a lumber, fuel and building material dealer in Beaver Dam, Wisconsin. A loan which he had made was unpaid and he was forced to bid in the property at a receiver's sale. Although totally unfamiliar with the business he determined not to be in ignorance of either his property or market conditions. A great deal of time and study was devoted to the questions, Mr. Starkweather says, and he discovered that although the state of Wisconsin was doing a great deal of road construction work, the glacier had deposited excellent gravel beds in nearly every county and his quarry probably would not be able to compete successfully with these deposits and the existing crushed stone operations over any very wide territory.

Mr. Starkweather was not satisfied with the market conditions in the crushed stone field in that locality either. His study finally led him to the idea of annexing his quarry which is located at Lannon, to his Central Lumber and Supply Company for producing architectural limestone.

Mr. Starkweather discovered that his quarry contained more fissures and cracks per hundred square feet than any other on which he could get information. Through these fissures water had seeped for ages depositing yellow and brown streaks of iron. He found that these irregular colorings were just the thing the architects desired and he saw a way to get his money out of the property and moreover develop a paying quarrying business.

He could not confine himself to the dimension stone business he soon found as the bottom part of the quarry did not have the distinctive colorations. There was, however, a good local demand for crushed stone and he had a market already under way through his lumber yard. Consequently only such material is crushed as is not suitable for the landscaping and building trade. This is the material more than 20 feet down on the face of the quarry. It is a hard blue limestone which compares favorably in crushing strength with granite or other superwearing road building material.

The top 20 feet of the quarry is stratified, the laminations running from 2 to 8 inches in thickness. The blocks cut from these strata are colored on both faces. They are used not only in public buildings but in many homes of the better class and in landscape gardening. The varying thickness of the stone adds much to its beauty in garden walls or building and those strata which are too thin for structural purposes are readily disposed of as flags.

When Mr. Starkweather came into possession of the quarry it was in a badly run down condition and although he recognized the conditions from his visits to modern plants he did not feel justified in making large mechanical installations until he knew whether or not his idea would pan out. Because of the keen competition he proceeded cautiously, purchasing only such equipment as he believed certainly increased his production and decreased cost.

The equipment now in operation consists of a number 4 and a number 6 Austin crusher, an electric hoist, and an electric well drill with a small compressor to get the stone into handling sizes. Blasts are set off by Cordeau-Bickford; Trojan powder is used.

BALANCED PUBLICITY IN THE LIME INDUSTRY

By R. P. Brown, Manager, Publicity Department, National Lime Association*

THERE are many factors which must be taken into consideration when an attempt is made to define balanced publicity. In an industry as diversified as the lime industry the details may become involved, but the basic principles remain constant.

Four main divisions at once come to mind when studying the problem. They are: 1—Types of material to be used; 2—Subjects to be treated; 3—To what class of readers will the material be distributed, and 4—How will this material be prepared and distributed.

Each of these main divisions is closely related to every other division and at the same time presents many special problems which in turn interlock.

Types of material vary. The highest type may be considered as the bulletin, which may range in size from a few pages up to a bound volume, suitable for use as a text book. More time should be given to the preparation of a bulletin than to any other single type of publicity, for it carries a prestige and weight not attained by other forms of material. Bulletins may be technical, semi-technical, popular, or purely sales talk, and of the high pressure type at that.

The first of the series of balances and studies which must be made before the whole program may be classed as balanced publicity comes in the preparation of an individual bulletin. Each succeeding balance will be discussed and weighed with due consideration of its position in the whole scheme.

First of all the subject of the bulletin must be balanced against the audience. Then, assuming that the manuscript has been prepared, the question of typography comes up with the type of cover to be used. A scientist pays little attention to covers, to printing, or to paper, but his influence must be considered and balanced with the rest of the items. He wants technical data, pure and unadulterated with popular material or sales talk. However, the form in which the material is presented helps to get it across quickly, and plays an important part in the impression conveyed. A purely technical bulletin requires a detailed scientific treatment of any subject, but does not play a major part in a promotional program. It is more suitable for institutional use.

The Association cannot issue many bulletins of the purely technical type, as its primary function is to encourage the use of lime in the commercial aspects rather than in the laboratory. This does not mean that technical material is not fundamental, but rather that such data should be presented in other forms than the bulletin.

The semi-technical bulletin has a broad appeal. Its phraseology, typography, paper and cover treatment are affected by the subject and class of readers. It may treat the same subject as does the purely technical bulletin, but not in the same detail, nor in as technical language. The man who will be interested by that type of publicity is perhaps designing construction or industrial processes, or acting in an advisory capacity to any field, including agriculture. He no longer has the time to study and analyze details. They must be omitted, and the gist of the subject presented in an authoritative, but graphic style.

Cover, paper and typography are important in such bulletins. The cover must be attractive, but severe rather than startling. The name of the organization issuing the bulletin means more to the technically trained, but busy reader, than does a pretty picture. Likewise, this type of bulletin must convey the idea of high character in its paper and layout, for a slipshod, careless piece of printing will convey the impression that the house of issue, to use a bankers' phrase, is not solid, and such an impression is hard to overcome even by the best of subject matter. Consequently a balance must be struck in choosing cover, paper and type.

Both the construction and chemical handbooks or "Manuals" may be considered as being of the semi-technical class, although certain sections of both are primarily technical. However, as they are not for general distribution detailed explanations of technical subjects are possible. Both of these publications are in the nature of reference books wherein some information will be found on practically any problem that may arise in the field. They are compact for easy carrying, yet complete for reference.

Many of the bulletins now issued by the National Lime Association may be classed as semi-technical. In the construction field, "Watertight Concrete," and "Workable Concrete," for examples, as are the Industrial bulletins dealing with chemical subjects such as "Varnish" and "Textiles."

"Studies in Lime," issued by the Kelley Island Lime and Transport Company, affords a good example of a semi-technical, yet popular bulletin issued by a company to describe their own material in more detail than can be done by the Association. Much care is evident in this bulletin. It is a good example of high class publicity, or rather direct mail advertising. It attains a good balance in material, art work and typography, cover and body

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paper, and is of interest to both the semi-technical and practical reader, as it contains both specifications and general information on the product.

The popular bulletin, which may cover a broad field or pertain to a single subject, has a wide use. It must be designed to reach and convince readers who may not have received a technical education, but who, through their own efforts, have achieved advancement. Such a reader likes to believe he has a grasp of a wide range of technical subjects, but immediately discards as "highbrow" anything which he cannot readily understand. Also, he refuses to consider anything which smacks of "primer" style. Therefore, a popular bulletin must be interesting to all who read; avoiding offense to those who are technically educated, and at the same time not appearing "highbrow" to those who have not been so educated.

The testimonial bulletin is popular. It should have a particularly attractive cover and should be well laid out and printed on a good grade of paper. Its purpose is to present in compact form the opinions of users, and care must be exercised in the selection of the material. Facsimile letters, supported by good illustrations of the work discussed, make a strong appeal, for it is only human nature to want to see examples of the use of a material and to know that the opinion you are forming is in accord with that of others whom you consider as authorities. The word of a friend, or the picture of a structure you are familiar with frequently means far more than any amount of talk. Bulletins of this nature can be made use of by company salesmen and association representatives.

The high pressure sales bulletin finds its place in intensive campaigns. It must be positive and striking in style, well prepared in every respect, and above all forceful. It must strike but one blow, but strike that blow hard. It is intended to cause a quick reaction, not to be filed for leisure, study and reference. It must be brief, using technical terms with discretion so as to convey to the ordinary average reader the idea that authorities have studied and spoken on the subject, yet popular and perhaps even breezy in character and style. It may be adapted to any subject, any reader class, or any method of distribution. A liberal use of color and white space is advisable in such bulletins, and their style makes possible a wide range of paper and typography.

The subject to be discussed will indicate the treatment. A campaign to use a new kind of shoe lace would hardly call for embossed or engraved work, but a high pressure bond selling campaign might warrant such treatment. Either might make use of color, and both should use care in typography, as the first impression is often a lasting one. Balance is particularly important in bulletins of this type.

The preparation of any type of publicity material requires a close cooperation between all departments of the association and the sales and advertising departments of member companies as well. For example, take the preparation of a bulletin or an article semi-technical in character, designed to reach a definite group. The subject may be suggested from the field, the publicity department, or any department in the Association. The first step is a conference between the publicity department and the department handling the subject. That department will furnish the data around which the bulletin or article is to be assembled. In the event that sufficient material is not available, the department will call on the research department or on the field men for additional information. When this is secured it will be turned over to the producing department to condense and work into the basic data already at hand. It is then returned to the publicity department for writing.

When the manuscript has been written, it is referred back for review and after technical approval is dressed up in final form and sent to press or submitted for publication. At every stage, absolute cooperation exists, thus utilizing to the best advantage all the facilities of the Association.

After bulletins, articles play an important part in the program. They may treat of any subject and be written for any class of reader. Material worthy of being developed into a bulletin of any of the types just discussed may be made the basis of an article, or of several articles, depending upon the amount and the importance of the subject. However, an article may treat a small subject in an interesting way, yet not warrant the expense of a bulletin, due to its limited use.

The range in articles is as wide as the trade and technical press. Each class of readers holds fast to a certain class of magazine. The producer must understand the users' problems, and an article on the fundamental properties of lime, which is of great interest to chemists, is likewise of interest to lime manufacturers. Consequently many articles written for consumers are also submitted to producer publications as well.

The primary function of the Association is to issue material of practical sales value, and results are only secured when that reaches users. Association effort is, therefore, directed toward the preparation of material for the consumer rather than the producer.

We must reach the technically trained man who is primarily concerned with practical problems and who has little time for details. The architect furnishes us with an example of that group. He reads the architectural papers, not having time for such material as is presented in "PIT AND QUARRY," or "Chemical and Metallurgical Engineering," although that may be of vital interest to another group. He may be reached through the medium of such papers as the "American Architect" and be interested in practical construction problems and their solutions; "Efflorescence," for example.

The popular type of article reaches a wide group of readers. For instance, a paper such as the "American Builder," has a circulation among builders. It is not restricted to the carpenter or small contractor, but reaches architects' offices and is at the same time on sale at the newstands for use by people who are interested in building their own homes and who want simple but authoritative information on materials and methods. Readers of this paper are interested in the practical every-day construction uses of lime for profit or for permanence.

Thousands of dealers are interested to learn more about the materials they handle. They read their trade papers, and information on lime and its uses will reach them through such papers as "Building Materials" and "Building Supply News."

The mechanic should not be forgotten in a well balanced publicity program, for he has the final handling of a material. Information relative to its properties and uses should be made available to him. The plasterer, who handles as much lime as any other single user, reads his trade publication, "The Plasterer," and feels confident that the editors have used care in selecting the material they pass along. Consequently, papers of that class should be supplied with material.

Typical examples only have been given. The field is unlimited. There are as many magazines reaching the industrial field as cover construction, and perhaps even more in agriculture. These must all be taken into consideration and the available time and effort balanced between the several fields, types of magazines and subjects. The field and opportunities exist; the problem is to get the material ready for the magazines, not to seek the outlet.

In fact, we have on file at the present time requests for fifteen articles, and if we were in a position to prepare the material we could place at least one article every week. The magazines want material, and turn first to national associations for articles, as the associations will present a subject in an impartial manner, without trying to sell a special brand of material or trying to get reading space for advertising matter. Also, it is only natural to expect that the association will have the best and latest information and consequently articles written by association men are usually considered as authoritative.

Still another type of good publicity is the folder. This may either list the uses of lime or be of a popular series describing one or more special uses. It may be a single sheet in one or more colors or a small booklet. Pamphlets that a dealer can give away are frequently of value in increasing sales. They may treat such subjects as specifications; as for example, whitewash or plaster, or they may present sales points for a particular product, amplifying what the dealer might say. Blotters and enclosures that a dealer or jobber can use with his correspondence serve to keep interest alive and the name of the company and product in the minds of prospective purchasers. This type of material offers an unlimited field for treatment, the only restriction being that it must be accurate as to statement.

Many members of the Association are already making good use of pamphlets and folders. These vary from a single sheet, printed on plain paper with black ink, to elaborate folders using several colors and being well illustrated with half tones and sketches. The little folders issued by the Merion Lime & Stone Company, the Sheboygan Lime Works, and those of the Kelley Island Lime & Transport Company dealing with construction and agricultural lime are good illustrations of effective, well balanced material of this class. The publications of the American Lime & Stone Company describing their chemical lime are also worthy of note.

Posters, either in color or black and white, attract attention. They vary in size from the small gummed sticker up to billboard dimensions, but a moderate sized, attractively designed, and well printed poster will usually find a place on the wall of a dealer's office. It may be just the thing that will decide a purchaser at the psychological moment and make a sale, or it may have a quiet but steady effect upon the dealer himself, arousing his interest in your product. Lime offers a golden opportunity for poster treatment, for its dealer possibilities in the construction and agricultural fields are unlimited. A poster emphasizing the agricultural possibilities of lime will stand a small chance in a city dealer's office, but one showing both the construction and agricultural uses will be of decided interest to the dealer in the smaller towns and agricultural communities.

The inherent desire we all have to be able to see things and ask questions at the same time makes the use of films and slides a valuable form of publicity. A moving picture will frequently answer all questions without a spoken word. If explanations are necessary they can be shown in a few short and simple sentences on the screen and the questions answered before they arise. Where equipment is available, lantern slides make possible a vivid exposition of a subject, for they permit of discussion and the effect of the speaker's personality. They are of special value in class room work. However, slides require special equipment, and heavy equipment at that, and are not particularly good for general use.

A new method of combined visual and oral presentation is available in the form of portable projectors and still films, and offers a happy solution of the problem of discussing a subject with groups. You will see how this film functions in connection with Mr. Elwell's paper. Such a presentation is of interest to all. It holds the interest longer than a paper without illustrations, and offers the opportunity of clinching points as they are made by showing a definite example and discussing it on the spot.

Still another important branch of this broad subject of publicity lies in the news sheet carrying a resumé of current material, interspersed with fundamental discussions of the basic subject. This is exemplified by the Agricultural Lime News Bulletin, which reaches county agents, dealers and farmers, with a steadily growing demand from teachers and students. It serves as a "roundtable," presenting under one cover the thoughts of authorities on lime in agriculture. Likewise it serves as a medium in which other uses of lime may be brought to the attention of the agricultural reader.

Last, but not least of the types of publicity material, come press releases. These are usually short, popular stories, discussing some subject of broad interest such as how to make a smooth concrete road, how millions can be saved by softened water, how fish life may be conserved, how to improve city garden and grass plots, etc., etc. While this material may seem light on first thought, it serves to arouse interest and create good will and eventually shows big results. For example a town may never have thought of softening its water supply. However, suppose the people read of how they can save more than the cost of the treatment in soap alone. That will start them thinking. Later on the women may read that hard water roughens and reddens their hands and that softening the city water supply with lime will help. That will arouse their interest. A series of short articles will appear on the merits of soft water, and incidentally the part lime plays in the process, all tending toward molding pubic opinion, which will later be expressed in a demand for a municipal water treatment plant. Who will say that such material does not pay?

Many of the daily and weekly agricultural newspapers are anxious to get good substantial material. They are only too glad to make use of an article telling of how lime will help get a good stand of alfalfa or clover, or of how to prepare and use sprays. They would welcome an article, "by special correspondence," which tells how the back roads can easily be made smooth and safe to travel in wet weather, all by the use of lime. The farmer who does not subscribe to any trade papers depends upon his newspaper, and it is only through the medium of "mats" and press releases that such materials can be made available to the individual.

Having summarized the types of material, let us consider how the balance must be struck. The backbone of the group lies in the semi-technical bulletin, for from it all others may be developed, the purely technical bulletin being perhaps the head and the other types filling out the body of the creation. More semi-technical and popular bulletins are required than anything else because it is the busy, practical reader who usually has the decision to make. Accordingly that is where the greatest effort is devoted.

Every bulletin, regardless of type, should be supported and balanced by at least one magazine article, frequently more. Folders and dealer helps still further supplement this work, but are more directly the function of member companies. News releases should go out regularly for there is always something of interest to the general public. They should be divided among the different subjects and among the various types of papers in such a way that they maintain a balance between the subjects treated and the class of readers, avoiding a continued series on any one subject unless there is particular local interest in that subject. Under that condition a special series of releases would be prepared for the local papers apart from the national program. At least two news releases should be issued for every bulletin.

The material in any given department must be kept in balance. It must first be balanced as to subjects, a decision being made as to which of the many items of interest can be treated. Then each problem attacked must be balanced, and so on in each department.

For example, the construction department has the five major divisions of mortar, plaster, concrete, stucco and concrete products under its immediate supervision. Due consideration must be given to all of them, and each must be balanced. Take for instance lime in concrete. At least two semi-technical bulletins are needed to treat watertightness and workability. One popular bulletin can cover the subject, although more would be better, and perhaps three folders will be useful. An interesting job offers the possibility of articles in practically all of the classes of magazines mentioned, and at least two should be written. A big job will afford an opportunity for one or more press releases and at the same time an item for the trade press. The amount of space given in a film will depend upon the audience, ranging from a few pictures up to a whole lecture.

The several departments in the Association must be in balance so that each receives a proportionate share of attention. If it is desired that a drive be made on industrial uses or any particular use, either special facilities must be provided or else time normally allotted to construction and agriculture must necessarily be reduced.

The audience must be studied and a balance arrived at as to which group must be supplied first and how the other groups are to be taken care of.

We have the scientific group in the laboratories, who are reached best by technical expositions of a subject. Shall they be given the most attention, or shall the semi-technical group which includes the engineers and architects, chief chemists, consultants, agricultural teachers and advisors be given first consideration? The still larger group, primarily interested in the practical aspects of a problem, such as superintendents, plant operators, smaller contractors, grange leaders, etc., calls for consideration and requires the more popular type of material. Likewise there are the important groups of dealers and mechanics who can push or retard the use of any material.

There is always room for difference of opinion, but we believe that the semi-technical and practical groups should receive the greatest attention. Next will come the dealers, followed by the purely technical group, and finally special attention should be given to the mechanics. The importance of this last group is great, but it is influenced by the first and second classes to a large extent and thus receives partial attention without special effort at the time. The purely technical class when interested will be likely to seek out the best source of information as they need it and will thus receive sufficient attention while the other groups are being supplied.

Finally we arrive at the extremely important question of how and where the material should be prepared and how it may best be utilized. It is primarily the function of this office to prepare Association literature, articles, press releases, etc., and to see that the special features are distributed through the proper channels. However, there remains the big problem of bulletin distribution.

It is our opinion that the association should see to it that purely technical material is distributed directly to the right parties, for usually the technicians are not directly concerned with sales. This office should also fill all direct individual requests for information, but every member should keep his finger on the pulse of trade by filling such requests himself as reach his office directly. Also, in order that the member may receive the greatest good from association material, he should stock the literature and distribute it to his prospects, either directly or through his dealers. By distributing this material, carrying his stamp or insert, he can secure the good will that naturally accrues to a company cooperating in an organization devoted to the good of the industry, and at the same time keep in direct touch with live prospects for sales. Many members are already doing this.

With all the basic data before him, a member of the association can determine from his intimate knowledge of his own product just what field it is most valuable in and can then proceed to amplify the association work by special literature of his own. Such material can and should be devoted to high pressure salesmanship, being designed for the sole purpose of selling his special product for a particular use. Its peculiar merits can be stressed and every effort bent to secure the order.

If the whole program as outlined above is not completed, the member can fill in the gaps by a series of his own publications. Special bulletins may be advisable, and surely a group of folders, dealer helps, enclosures, etc., cannot fail to be productive.

Thus the member companies finally balance the whole program, utilizing the resources of the association to increase the total use of lime, its formation as a basis for their own individual campaigns, and a combination of association literature and their own material to offer purchasers or prospects a complete and balanced service.

Balanced publicity in the lime industry therefore consists of the following:

1. Balance as to type of material.
2. Balance as to subject matter.
3. Balance as to readers.
4. Balance in departments.
5. Balance between departments.
6. Balance in the Association.
7. Balance between Association and Members.

VALUABLE OPEN MEETINGS

President Haddow of the National Sand and Gravel Association called an open meeting of the Executive Committee of the Association which convened at the Book-Cadillac Hotel, Detroit, on Wednesday, June 30, beginning with a luncheon at 12:30. The purpose of these open meetings is to enable the Executive Committee of the National Sand and Gravel Association to acquaint themselves with problems in the various sand and gravel producing districts, and to aid producers in solving these problems in order that the local and national industry may be firmly established all over the country. Attendance at these meetings is not restricted to members of the association, and the results of past meetings have been most gratifying.

A cordial invitation is extended to interested member companies to attend these meetings, and they are at liberty to extend the same invitation to non-member companies. Attendance is worthwhile.

LIMESTONE DOUBLES CARRYING CAPACITY

In Scioto County, Ohio, an experiment has been in progress to find the relative carrying power of treated and untreated pastures. There was a thirty-six acre field twelve acres of which were given a treatment of 1½ tons of limestone and 400 pounds of acid phosphate per acre and fenced off. No seed was sown. Cattle were turned in on both the treated twelve acres and the untreated twenty-four acres, and both were pastured to capacity all season.

The results showed that on the twenty-four acre, untreated pasture the gain on the cattle was 1,420 pounds, while on the twelve acre, limestone and acid phosphate pasture the gain on the cattle was 1,640 pounds.

SPECIALIZING IN ROAD BASE STONE

CONNELL and Schultz of Inverness, Florida, have specialized in one branch of the crushed stone business and are producing only shell rock for road base. Four quarries and crushing plants with a combined capacity of 70 car loads daily are now in operation and a fifth is expected to be running within a few weeks.

The use to which the material is put obviates the necessity of separating after crushing and there are no screens nor storage bins at any of the plants. The Lowell plant at McAllister Spur, Florida, is typical of all the company's operations. The photographs accompanying this article were taken there.

The overburden here is usually about 4 feet thick and is removed by an Erie steam shovel. The rock is drilled with a cup drill. Holes are made 18 feet apart and 30 feet deep. Primary blasting is done with powder and secondary with du Pont dynamite. The rock brought down is loaded into cars made by the Maddox Foundry and Machine Company by an Erie steam shovel.

They are hauled up a 100 foot incline with a 35 foot rise by a hoist and the rock is fed to a 60 inch roll crusher made by Maddox Foundry and Machine Company. The cars descend the incline by gravity and the material passing through the crusher is discharged directly into freight cars. This plant is under the direct supervision of Mr. Schultz and J. M. Connell. It has a capacity of 20 cars daily. Power for the hoist and crusher is obtained from a Fairbanks-Morse oil engine.

The two plants at Hooper which are under the supervision of J. L. Connell have a combined capacity of 30 cars daily. Here the stripping is done by teams and by wheelbarrows. The crushing operation is identical, rolls of the same make and dimension being used. P. & H. gasoline shovels are used at both Hooper plants for loading stone into cars. Both of these locations are on the Atlantic Coast Line railroad and there is no shipping by trucks. During the Florida rush last winter the organization suffered from car shortage but as the situation is rapidly being remedied it is believed the problem will not have to be met this summer.

The Williston plant which is on the same general plan was opened early this year and the firm expects to open another in this location within a few weeks.

Before the Blast

During the Blast

After the Blast

Loading Road Base Directly Into Cars

VIBRATING SCREENS FOR SAND AND GRAVEL PLANTS

By Harry Strube, Engineer, Link Belt Company

THERE are two methods of sizing sand and gravel over screens, i. e., by the wet process, where sufficient water is added, either as a mixture or in the form of sprays; and the dry process, where material is handled just as it comes from the pit. With the increasing exactness of specifications for concrete aggregates, not only is it necessary that loam, clay and other foreign substances be removed, but a clean separation of the sand from the gravel must be made. It is obvious that this can be done only with the assistance of water, so that about the only places where dry screening is permissible are in isolated cases, where specifications have no bearing, and in the preparation of material for gravel roads. Occasionally one sees an exceptionally clean bank of sand which can be used just as it appears, but this is a rare occurrence.

Modern plants having a production of, say, 200 tons or over per ten hour day, are generally called upon to separate gravel into three sizes, and sand into two. The largest gravel used for concrete work is up to pieces passing through a 2½-inch round perforation. This is used for concrete road foundations, and ranges from 2½-inch maximum to a ⅜-inch minimum, with the pebbles graded uniformly. For instance, in New Jersey, not over 25 to 40 per cent of gravel must pass through ¾-inch round openings. Pebbles thus uniformly graded make stronger concrete.

Gravel for building and commercial concrete ranges from that passing through 1½-inch to 1¾-inch round openings, down to sand. Roofing or pea gravel usually passes through ¾ or ⅝-inch round openings, and is retained on ⅜ or 5/16-inch. Ordinary torpedo sand used for concrete work passes through ⅜ or 5/16-inch round holes, and ranges down to the extreme fines, although for good concrete sand these fines should be limited. The various State specifications vary as to permissible fines, but the object is to obtain a uniform grading which will provide for filling all voids, and make a homogeneous mass. Often times pits carry an excess of fines, and their removal becomes a problem of water classification or screening.

The other size of sand is for plaster or brick work. It usually is obtained by robbing the concrete sand of a portion of its fines, which is commonly accomplished by passing the concrete sand, with a plentiful supply of water, over a stationary slotted plate or launder, having slots about 1/16x1 inch. This removes a portion of the fines from the concrete sand, but enough still remains to give a good quality sand. This is a rough process and in ordinary pits is sufficiently effective, but where the percentage of fines in the concrete sand is too high to remove them in sufficient quantities by this method, either water classification of more careful screening is required.

Sand separators can be made to remove the majority of 5 or 60 mesh and finer sand grains, but, of course, will not classify the sand in strict accordance with size. Our present information shows that the vibrating screen cannot be used economically on meshes less than about thirty on the washing process, due to the fragile nature of the screen cloth. The meshes are soon filled because there is not sufficient rigidity in the cloth to transmit effective vibrations. When once filled, the sand grains cannot be dislodged except by destroying the meshes. If the sand separator or vibrating screen does not suffice, the alternative is a water classifier. The two accepted types of screens for grading sand and gravel are the revolving and vibrating types.

In the dry separation, the presence of natural moisture makes it impossible to use a screen mesh of less than ⅛ inch on a vibrating screen, and about ½ inch on the revolving type. For this class of work the vibrating screen has the advantage. The coiled wire cloth is well adapted here, although the smallest space that can be made between wires is ⅛ inch. In dry screening, neither the revolving nor the vibrating screen will make clean cut separation of sand from gravel.

In wet separation, both the revolving and the vibrating types have their limitations. The former begin to blind when the openings get down as small as ⅜ to 5/16-inch, while the latter work best when fitted with cloths having about 1 inch clear openings and under. Where the material contains dirt and clay the revolving screen is by all means the best adapted, because of its scouring action, which, with the assistance of water, removes the coating from gravel particles. The vibrating screen merely acts as a grader, and, aside from the force of water sprays, will not remove foreign materials as readily as the revolving screen.

For most plants therefore, a rule may be formulated to the effect that the revolving screen should be used for openings down to 5/16 or ¼ inch, while for finer separations the vibrating type is best adapted.

In the ordinary washing plant where the percentage of sand and gravel are normal, or, in other words, where there is no large excess of any one of the finer sizes, the standard system will handle the material perfectly, dividing it into two or three sizes of gravel and one or two sizes of sand. But if there is a preponderance of sand in the gravel, or an overabundance of fine sand, the vibrating screen can be added to the equipment to produce a cleaner separation.

Reasons for Installing Revolving Screens for Washing and Grading Sand and Gravel

1. Scrubbing action of screen jacket against material, and of material against itself, removes with the aid of water sprays, such foreign matter from the surface of the pebbles as clay and loam.
2. Materials remain in a revolving screen longer than on a vibrating screen, due to the fact that the pitch of former is about 1¼ in 12 inches, while that of the latter is 8 in 12 inches.
3. Revolving screens are capable of withstanding overloads (without losing efficiency) better than vibrating screens.
4. Revolving screens are good distributors over bins or storage piles, whereas vibrating screens require longer chutes.
5. Revolving screens take considerably less height over the top of a bin than vibrating screens making the same separations.
6. Down to ⅜-inch round openings, revolving screens will make a perfect separation of the sand from the gravel, unless there is an overabundance of the former.
7. A revolving screen installation is usually cheaper, compared to one using vibrating screens for the same separation.

Reasons for Installing Vibrating Screens for Washing Sand and Gravel

1. For openings less than 5/16-inch, the vibrating screen is the only type capable of maintaining open meshes.
2. The screen cloth can be replaced in comparatively few minutes where there is a demand for quick change in specifications for gravel or sand.
3. The installation is very compact where quarters are crowded.
4. The application of power is simple.
5. Where material is free from objectionable foreign matter, the vibrating screen will grade from 1-inch openings down to 30 mesh, better than the revolving screen.

A WORD ABOUT SHOVEL TYPES AND USES

Recently, in an interview, a prominent designer of power shovels made the following comments on the natural grouping of shovels by types and capacities:

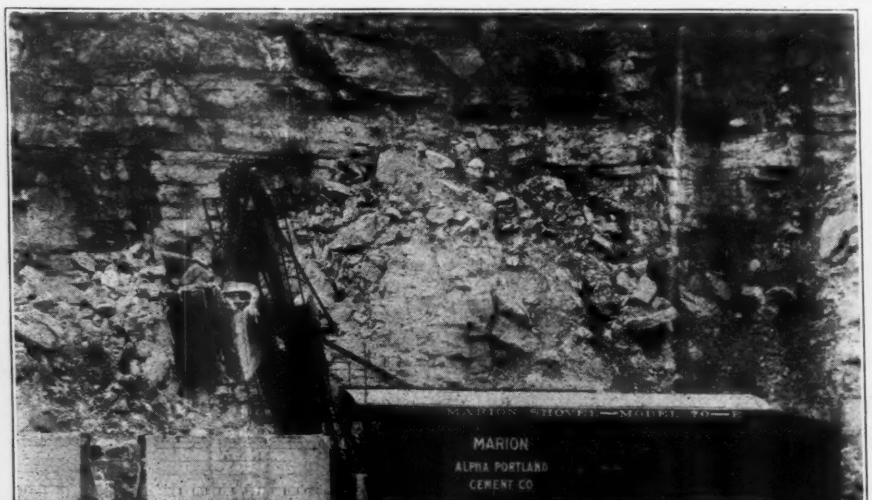
"For all practical purposes there is no general utility power shovel outside what is known as the small revolving class with capacities ranging up to two cubic yards. That is the range in demand by contractors, and contractors, broadly speaking, are the only users of general purpose shovels. Few general contractors own or want shovels larger than two cubic yards capacity at the outside. The whole thing is merely a matter of economics. Thus contracting shovels fall automatically into a well defined group within what may safely be regarded as an arbitrary capacity limit of two yards or less.

"Beyond this group of contractors' shovels there is practically no field for all-purpose or general utility shovels. Shovels larger than two cubic yards capacity are practically always bought for a specific use. And, because uses for larger shovels are so widely varied, it has brought about the establishment of two distinct types for the various kinds of heavy duty service. These are the heavy revolving type and the railroad type.

"The railroad type shovel is without question by far the more economical and productive on several types of service where the operating radius is restricted and the material heavy and obstinate. It is impossible to design a revolving shovel to take the place of a railroad type. There are good reasons why, else there would be no railroad type shovels built. One reason is that a revolving shovel, to take the place of a railroad type, must be made so compact as to infringe upon the proper diameter of the roller path, thus sacrificing stability in the face of service which requires the utmost stability. This is something that cannot be overcome by counterbalance for a counterweight heavy enough to impart stability to a small roller path shovel in rock would be too heavy for multi-purpose work. Furthermore, the railroad type shovel has an inherent advantage for close quarters work in its short boom and dipper stick. Due to the shortness of the swing as compared with a revolving shovel of equivalent dipper size, a railroad type shovel is far faster in loading out. A railroad type shovel can rapidly load and swing in quarters so narrow that its cab may be but a few feet from the parallel bank face—it might be against the face for that matter—while manifestly, swinging would be impossible for a revolving shovel under those conditions.

"So, where the digging is hard and the demands heavy, there is no revolving shovel that can equal or even approach the railroad type. But for the much broader range of uses where the operating radius is wide and the face high, in fact in all places where there's "room for the tail where the head ought to be," the larger square-built, no compromise, revolving shovel is the thing.

"Thus do power shovel manufacturers find it necessary to build three distinct groups of machines: the small revolving group with capacities up to two cubic yards, the railroad type in several sizes, and the larger revolving group."



An Electrically Operated Shovel of Modern Design

RECENT PATENTS

The following patents of interest to readers of this journal recently were issued from the United States Patent Office. Copies thereof may be obtained from R. E. Burnham, patent and trade-mark attorney, Continental Trust Building, Washington, D. C., at the rate of 20 cents each. State number of patent and name of inventor when ordering.

1,585,041. Mining-machine. Roderick MacEachen, Washington, D. C.

1,585,052. Crusher. Albert H. Stebbins, Los Angeles, Cal.

1,585,423. Hoist machanism for power loaders. Samuel Shafer, Jr., and Lloyd H. Draeger, Milwaukee, Wis., assignors to Chain Belt Co., same place.

1,585,461. Screening apparatus. Francis W. Brackett, Colchester, England.

1,585,916. Mining-machine. Morris P. Holmes, Claremont, N. H., assignor to Sullivan Machinery Co., same place.

1,585,917. Mining-machine. Morris P. Holmes, Claremont, N. H., assignor to Sullivan Machinery Co., same place.

1,586,012. Power - shovel. William W. Sloane, Chicago, Ill., assignor to Goodman Mfg. Co., same place.

1,586,021. Cutter-chain. John W. Zellers, Chicago, Ill., assignor to Goodman Mfg. Co., same place.

1,586,023. Grab. Dudley J. Barnard, Barking, England.

1,586,318. Means for burning lime. John T. Mabee, Chicago, Ill., assignor to Raymond Bros. Engineering Co., same place.

1,586,573. Loading-machine. Norton A. Newdick, Columbus, Ohio, assignor to Coloder Co., same place.

1,587,085. Rock - crusher. Charles B. Rogers, Joplin, Mo.

1,587,479. Rock-grab. Thomas L. Durocher, Detour, Mich.

THE DIAMOND HOISTS

The Diamond Machine Company manufatcure a line of keyed and friction drum electric hoists as well as a line of electric rock drills.

This line of Diamond hoists represent a line of simple rugged machines of ample strength. The bed plate is cast iron of box section type. The bearing pedestals are cast integral with the side frames. The drum and intermediate shaft bearings are of the rolling mill type with cast pocket oil chambers. The gears are cast steel mating with forged steel pinions. All gears have machine cut teeth. The shafting is of good quality open hearth steel. There is a Diamond keyed or friction electric drum hoist for practically every purpose in a pit or quarry.

EFFICIENT SCREENING AT A SMALL PLANT

South St. Paul, Minnesota, known principally for its stock yards and packing houses, is the home of an interesting sand and gravel plant operated by the United Materials Company. The plant which has a capacity of 1,000 tons of finished product daily, ships by rail and truck and is so located that boat shipments are possible should they be required. Three sizes of gravel, 2, 1½ and ½ inch, and two grades of sand, concrete and plaster are produced.

The overburden of the pit is removed with a Byers "Bear Cat" stripper which loads into dump wagons. The material is excavated with an Erie shovel and loaded into Koppel cars which are hauled to the electrically operated plant by a Whitcomb gasoline locomotive. The material is dumped into a hopper which feeds a belt conveyor leading to the scalping screen. This is a Telsmith revolving with a scrubber section. The first section of the screen has ½ inch openings and the second section has 1¼ inch openings.

All material passing through the first section goes to two Diester Concentrator Leahy vibrating screens which separate the concrete sand, plaster sand and roofing gravel. Oversize from the revolving screen goes to a jaw crusher. City water is used for washing and a spray at a loading chute washes the gravel as it goes to the trucks.

The screen is set atop the five loading bins which have a capacity of 700 cubic yards. The officers of the United Materials Company are F. J. Morse, president, and Bernard S. Andrus, treasurer and general manager.

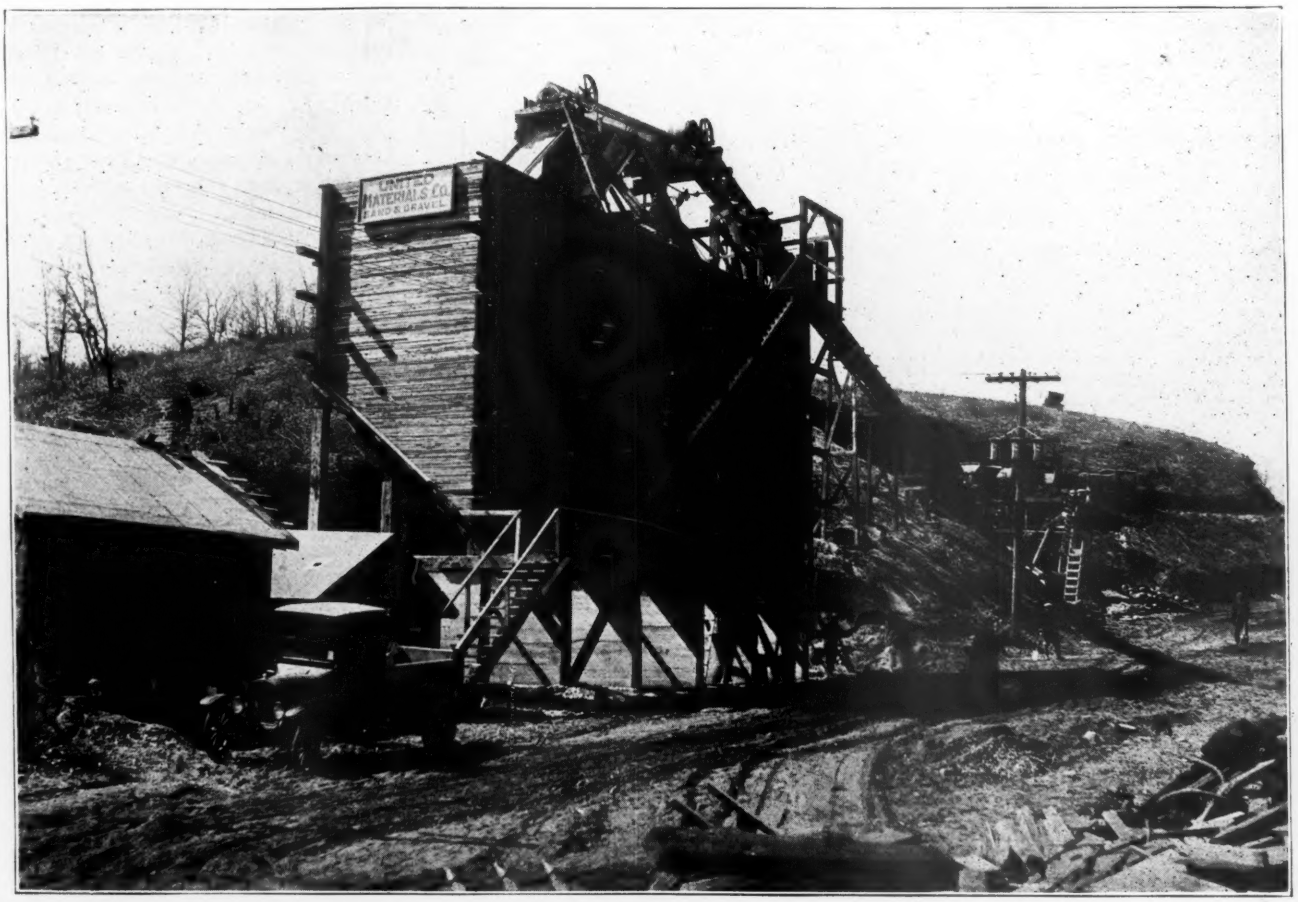
RAILROAD COOPERATION

An interesting effort to aid the farmers was made by the New York Central road in its soil-fertility train which was operated in southeastern Michigan this spring. Twenty-eight stops were made during a two weeks' run. Samples of soil were tested for the farmers who were informed as to what their soil needed in lime and as to its content of organic matter. They were given in each case written recommendations as to crops, needs for lime and fertilizers, etc. The train contained a lecture and motion picture car, and a soil analysis laboratory. There were exhibits giving every possible kind of valuable information. Such educational work is of inestimable value to anyone interested in farming.

WILLIAM E. CARSON HONORED

Announcement has been made by Governor Harry F. Byrd of Virginia of the appointment of William E. Carson as head of the Commission of Conservation and Development which was created by the general assembly at its last session. This commission replaces the geological survey, the geological commission, the water power development commission and the forestry commission, thus becoming of great importance in the state. It will have complete supervision of the Shenandoah National Park as well as certain authority over other state parks. The fifty thousand dollar state advertising fund of Virginia will be handled by this commission as well as the development and conservation of the state's resources.

Mr. Carson is president of the Riverton Lime Company of Riverton, Virginia. He was president of the National Lime Association for fifteen years and is widely known as a business leader. Mr. Carson has held many other important positions both state and federal, and this most recent appointment is in line with the confidence which those who know Mr. Carson have in him.



The Plant of the United Materials Company at South Saint Paul, Minnesota

DISTRIBUTION OF CEMENT

Portland Cement Shipped from Mills into States in March and April, 1925 and 1926, in barrels*

Shipped to—	March 1925	March 1926	April 1925	April 1926
Alabama	177,510	158,310	191,451	215,372
Alaska	294	917	709	957
Arizona	27,009	54,916	31,264	40,257
Arkansas	72,198	66,712	94,695	62,646
California	1,029,118	1,156,509	1,027,744	850,124
Colorado	102,537	81,623	131,363	104,386
Connecticut	113,668	78,962	160,616	149,459
Delaware	21,766	22,386	41,573	48,259
District of Columbia	58,474	63,249	70,765	82,579
Florida	272,094	402,888	261,180	323,909
Georgia	140,634	139,781	112,250	171,829
Hawaii	1,500	24,737	2,250	27,999
Idaho	17,667	42,131	28,393	47,688
Illinois	846,638	569,978	1,467,815	961,090
Indiana	255,597	189,947	433,996	309,435
Iowa	161,164	116,367	284,477	219,716
Kansas	212,402	182,003	232,220	204,165
Kentucky	115,222	88,756	174,795	141,204
Louisiana	98,193	96,214	108,250	99,889
Maine	21,702	18,302	36,163	33,345
Maryland	143,291	132,720	207,844	199,076
Massachusetts	257,381	168,271	344,406	298,326
Michigan	437,712	399,036	859,815	582,549
Minnesota	173,618	164,405	321,854	296,040
Mississippi	35,778	58,308	48,174	65,511
Missouri	379,157	332,104	489,316	505,850
Montana	16,450	17,203	23,030	23,063
Nebraska	99,780	121,456	180,951	170,591
Nevada	7,254	8,824	10,767	8,478
New Hampshire	27,592	18,043	39,906	37,909
New Jersey	498,227	424,812	722,751	597,846
New Mexico	18,865	18,594	19,699	71,794
New York	1,159,830	1,026,883	1,717,441	1,633,792
North Carolina	200,097	271,422	277,616	357,978
North Dakota	16,589	23,260	38,937	39,039
Ohio	592,069	419,623	894,683	668,293
Oklahoma	203,161	206,766	201,886	220,016
Oregon	103,813	117,611	101,661	126,874
Pennsylvania	808,636	745,142	1,250,501	1,242,840
Porto Rico	0	0	0	0
Rhode Island	54,083	34,838	79,063	64,303
South Carolina	72,929	69,811	65,806	49,573
South Dakota	40,697	38,194	57,039	43,693
Tennessee	116,856	117,610	133,037	178,683
Texas	381,320	367,833	401,517	411,203
Utah	28,567	37,117	33,469	35,218
Vermont	10,312	5,052	25,353	14,358
Virginia	132,891	121,765	160,139	161,284
Washington	151,814	152,534	180,845	189,037
West Virginia	85,703	89,054	134,357	154,113
Wisconsin	142,620	155,826	358,379	277,196
Wyoming	16,358	12,225	19,981	13,887
Unspecified	46,236	36,878	34,875	56,420
	10,205,073	9,467,908	14,327,067	12,889,141
Foreign Countries	73,927	71,092	66,933	71,859
Total shipped from cement plants	10,279,000	9,539,000	14,394,000	12,961,000

*Including estimated distribution of shipments from three plants each month.

Production, Shipments and Stocks of Finished Portland Cement by Districts, in May, 1925 and 1926, and Stocks in April, 1926, in Barrels

Commercial District	Production May 1925	Production May 1926	Shipments May 1925	Shipments May 1926	Stocks at end of May 1925	Stocks at end of May 1926	Stocks at end of April, '26
Eastern Pa., N. J. & Md.	3,660,000	3,939,000	4,125,000	4,620,000	4,106,000	4,630,000	5,311,000
New York	838,000	861,000	907,000	928,000	1,164,000	1,418,000	*1,485,000
Ohio, Western Pa. & W. Va.	1,540,000	1,781,000	1,590,000	1,886,000	1,966,000	2,616,000	2,721,000
Mich.	1,120,000	1,289,000	1,201,000	1,301,000	1,245,000	1,920,000	1,932,000
Wis., Il., Ind. & Ky.	2,400,000	†2,255,000	2,586,000	†2,618,000	3,218,000	†3,454,000	3,817,000
Va., Tenn., Ala. & Ga.	1,162,000	1,418,000	1,233,000	1,420,000	611,000	1,057,000	1,059,000
Eastern Mo., Ia., Minn. & S. Dak.	1,552,000	1,518,000	1,714,000	1,777,000	3,067,000	2,819,000	3,078,000
Western Mo., Neb., Kans. & Okla.	1,130,000	1,116,000	1,169,000	1,130,000	1,558,000	1,429,000	1,443,000
Texas	392,000	454,000	429,000	447,000	258,000	508,000	501,000
Calif.	1,067,000	1,229,000	1,130,000	1,252,000	473,000	529,000	552,000
Colo. & Utah	265,000	†607,000 (Colo. & Utah; Ore., Wash. & Mont.)	227,000	†571,000 (Colo. & Utah; Ore., Wash. & Mont.)	350,000	†777,000 (Colo. & Utah; Ore., Wash. & Mont.)	741,000 (Colo. & Utah; Ore., Wash. & Mont.)
Ore., Wash. & Mont.	377,000		424,000		424,000		
	15,503,000	†16,467,000	16,735,000	†17,950,000	18,440,000	†21,157,000	*22,640,000

*Revised. †Figures include estimate for one plant each in Indiana and Utah and are subject to revision.

Estimated Clinker (underground cement) at the Mills at End of each Month, 1925 and 1926, in Barrels

Month	1925	1926	Month	1925	1926
January	7,017,000	9,074,000	July	6,961,000	....
February	8,497,000	10,931,000	August	5,640,000	....
March	9,962,000	12,284,000	September	4,561,000	....
April	9,731,000	12,934,000*	October	4,086,000	....
May	9,053,000	11,619,000	November	5,013,000	....
June	7,937,000	....	December	6,469,000	....

*Revised.

Age of Minerals and Rocks

During the last two decades increased knowledge of the phenomena of radioactivity, conjoined with analyses of minerals, has brought to the front a new measuring stick for determining the age of minerals and rocks. The work by this new method is little more than begun but enough has been accomplished to indicate the age of the globe as computable in hundreds of millions of years, rather than in tens of millions as has often been heretofore assumed. Somewhat as the hardening of the bones indicates the age of a human being, so the accumulation of helium and lead in uranium and thorium minerals indicates their age, but on a scale whose units are millions of years. The criterion is based on the fact that helium and lead are the end products of the radioactive decay of the elements uranium and thorium, and the age of the rock is computed from the rate of such decay and the quantities of these substances the rock contains.

Time relations have always been of major interest in geology. Both practical and theoretical geologists need to know in the study of rocks and minerals which were formed earlier and which were later. The mere observation of relative position was for a long time the only guide; then came correlation by means of fossils of extinct animals; and finally attempts have been made to estimate the length of time required to deposit the sedimentary strata or to cut gorges, or the time required for sediments to shrink, for the earth to cool, and the like; and some of these estimates have even led to speculations concerning the age of the earth itself.

The chemical laboratory of the Geological Survey, Department of the Interior, has furnished many of the analyses by which the age of minerals and rocks may be computed from their content of helium and lead. The making of analyses useful for this purpose is a complex process. Hillebrand early set the standard; and even he, in his extended work on uraninites, failed to discover that part of the "nitrogen" gas he measured was helium. In the popular conception an analysis of a mineral or a rock is perhaps a simple and quick operation like an assay for gold; but a mineral analysis may consume weeks of time and study—in fact, the combinations of elements in the rarer minerals are so variable that their complete analysis may require months. Few standard methods of procedure are available as guides. For the purpose of determining the age of minerals, however, only the percentages of uranium, thorium, helium, and lead seem to be absolutely necessary at present, and when more experience has been gained in their estimation the time required for the analytical work may be shortened considerably. The minerals to be analyzed for age determinations must be carefully selected with regard to their freshness and geologic sequence, if that can be established.

This method of determining the age of minerals and rocks has been studied rather extensively abroad, particularly in England and Austria. In this country the problem has recently been taken up under the auspices of the National Research Council through cooperation of a number of scientists and various institutions, including the Geological Survey, the Geophysical Laboratory, Harvard University, and other agencies. A table of minerals, showing their geologic horizons and their age computed by this method, has been prepared for the International Critical Tables of Constants, which are being published under the auspices of the National Academy of Sciences and the National Research Council.

As this method of investigation is comparatively new the accumulation of further data is greatly needed. More of these difficult analyses should be made, especially of minerals which contain uranium, thorium, and rare earths and whose geologic horizons are known.

The study of minerals that may serve as age indicators is being continued in the chemical laboratory of the Geological Survey. Subsidiary to the problems of analysis are the problems of separating a sufficient quantity of these particular minerals for analysis from a large mass of granite and of accounting for their rather general occurrence in pegmatites, and the correlation of determinations of age based on laws of radioactive decay with those made in other ways.

LOSS OF NITRATES FROM SOIL

Bulletin Number 205, published by the Arkansas Agricultural Experiment Station gives some valuable information regarding the loss of nitrates from the soil during winter. Experiments were carried on to determine the effect of cultivation on the moisture and the nitrate in the soil. The data gathered from these tests prove that the nitrate in the soil in the fall has disappeared by spring, and nitrogen applied in one year is not likely to be available for the next year's crop. It is almost completely removed from the soil by the winter's rains. It is therefore desirable to apply nitrogen in fertilizers in the spring.

Production, Shipments and Stocks of Finished Portland Cement by months, in 1925 and 1926, in Barrels

Month	Production 1925	Production 1926	Shipments 1925	Shipments 1926	Stocks at end of month 1925	Stocks at end of month 1926
January	8,856,000	7,887,000	5,162,000	5,672,000	17,656,000	20,582,000
February	8,255,000	7,731,000	6,015,000	5,820,000	19,897,000	22,384,000
March	11,034,000	10,355,000	10,279,000	9,539,000	20,469,000	23,200,000
1st quarter	28,145,000	25,973,000	21,456,000	21,031,000	....	....
April	13,807,000	*12,401,000	14,394,000	*12,961,000	19,882,000	*22,640,000
May	15,503,000	*16,467,000	16,735,000	†17,950,000	18,440,000	†21,157,000
June	15,387,000	....	17,501,000	....	16,409,000	....
2d quarter	44,697,000	....	48,630,000	....	....	....
July	15,641,000	....	18,131,000	....	13,896,000	....
August	16,419,000	....	18,383,000	....	11,952,000	....
September	15,939,000	....	17,711,000	....	10,247,000	....
3rd quarter	47,999,000	....	54,225,000	....	....	....
October	15,992,000	....	15,309,000	....	10,979,000	....
November	13,656,000	....	10,187,000	....	14,534,000	....
December	10,713,000	....	6,917,000	....	18,365,000	....
4th quarter	40,361,000	....	32,413,000	....	....	....
	161,202,000	....	156,724,000	....	....	....

*Revised. †Includes estimate for two plants and subject to revision.

EXPORTS AND IMPORTS

Exports of Hydraulic Cement by Countries, in April, 1926

Exported to—	Barrels	Value
Canada	1,927	$ 9,645
Central America	15,660	35,506
Cuba	9,466	24,254
Other West Indies	6,284	17,020
Mexico	10,330	30,563
South America	47,054	135,427
Other countries	5,575	32,357
	96,296	$284,772

Imports of Hydraulic Cement by Countries and by Districts, in April, 1926

	District into which imported—	Barrels	Value
Belgium	Florida	102,027	$154,400
	Massachusetts	28,101	42,804
	Mobile	11,879	18,106
	New Orleans	18,146	26,297
	Philadelphia	28,054	42,427
	San Francisco	24	36
	South Carolina	2,979	4,711
	Washington	11,975	15,879
	Total	203,185	$304,660
Denmark and Faroe Islands	Florida	20,666	33,663
	Porto Rico	24,408	38,425
	Total	45,074	$72,088
United Kingdom	Los Angeles	2,222	6,710
	Porto Rico	1,704	3,866
	Total	3,926	$10,576
Canada	Maine and New Hampshire	......	4
	St. Lawrence	2,276	5,288
	Total	2,276	$5,292
France	New York	1,751	3,514
Greece	New York	......	5
Japan	Hawaii	1,060	1,657
Sweden	New York	30	322
	Grand Total	257,302	$398,114

Imports and Exports of Hydraulic Cement by Months, in 1925 and 1926

Month	Imports 1925 Barrels	Imports 1925 Value	Imports 1926 Barrels	Imports 1926 Value	Exports 1925 Barrels	Exports 1925 Value	Exports 1926 Barrels	Exports 1926 Value
January	231,258	$364,196	360,580	$576,717	71,596	$207,547	72,939	$216,431
February	119,077	206,308	314,118	527,948	56,249	181,356	73,975	220,706
March	218,048	337,039	493,241	812,968	65,248	200,410	69,080	205,647
April	197,686	280,826	257.302	398,114	89.508	263,831	96.296	284.772
May	186,897	286,959	(†)	(†)	85,385	250,845	(†)	(†)
June	254,937	409,539	....	....	71,343	217,899	....	....
July	335,118	499,602	....	....	98,141	286,543	....	....
August	379,847	611,551	....	....	103,961	289,904	....	....
September	513,252	789,121	....	....	102,649	285,225	....	....
October	535,050	824,268	....	....	73,369	228,467	....	....
November	388.604	678,518	....	....	101.825	294,201	....	....
December	295,543	526,001	....	....	100,323	296,900	....	....
	3,655,317	$5,813,928	....	....	1,019,597	$3,003,128	....	....

Domestic Hydraulic Cement Shipped to Alaska, Hawaii, and Porto Rico in April, 1926*

	Barrels	Value
Alaska	2,639	$ 8,369
Hawaii	22,816	51,538
Porto Rico	7,535	19,212
	32,990	$79,119

*Compiled from the records of the Bureau of Foreign and Domestic Commerce and subject to revision. †Imports and exports in May, 1926, not available.

ASPHALT SALES INCREASE IN 1925

Sales of asphalt and asphaltic materials manufactured from petroleum at refineries in the United States during 1925 amounted to a total of 3,178,370 short tons, which is an increase over the 1924 sales of nearly 100,000 tons, or 3 per cent, according to the Bureau of Mines, Department of Commerce. These sales were valued at $42,825,770, an increase over 1924 of 19 per cent. Of the total sales during 1925, 1,206,700 tons, with a value of $15,305,760, was manufactured from domestic crude petroleum, and 1,971,670 tons, with a value of $27,520,010, was produced from foreign crude petroleum. The Atlantic Seaboard refineries held first rank as manufacturers of asphalt in 1925, their sales of 1,313,270 tons (practically all of which was from foreign petroleum) comprising 41 per cent of the total for the United States. Asphalt for paving purposes was again the most important variety, its production registering a gain of 1925. Asphalt to be used in the roofing and waterproofing trades was second in importance, but its production remained stationary as compared to 1924.

Sales at the mine of native asphalt and related bitumens in the United States in 1925, including bituminous rock, gilsonite, and wurtzilite (elaterite), amounted to 584,850 short tons, valued at $4,148,400. This is an increase over 1924 of 4 per cent in quantity and of 5 per cent in value. Kentucky led in the production of these materials. Of the various products bituminous rock was first in quantity and value.

Imports (general) of asphalt of all kinds for 1925 amounted to 122,162 short tons, a decrease from 1924 of 24 per cent. Exports in 1925 amounted to 121,849 short tons, of which 89,014 tons was petroleum asphalt.

PRODUCTION OF FELDSPAR IN 1925

The crude feldspar sold or used by producers in the United States in 1925 amounted to about 184,100 long tons, valued at about $1,306,300, according to a statement prepared from reports received directly from producers and issued by the Bureau of Mines, Department of Commerce, in cooperation with the geological surveys of Maryland, New York, North Carolina, and Virginia. These figures show a decrease of 10 per cent in quantity and 13 per cent in value compared with 1924. Feldspar was mined and sold in 1925 in 12 states, namely, Arizona, California, Colorado, Connecticut, Maine, Maryland, New Haven, New York, North Carolina, Pennsylvania, South Dakota and Virginia. The greatest feldspar-producing region is that which includes the Atlantic seaboard states, from Maine to North Carolina. This region reported about 93 per cent of the total production and value in 1925. North Carolina, the leading state, reported about 41 per cent of the total output; New Hampshire, the second state, reported 21 per cent; and Maine, the third, 15 per cent. The average value per long ton in North Carolina was $6.48; in New Hampshire, $7.28; and in Maine, $9.04.

Except for minor purposes feldspar is prepared for use by grinding. This work is done principally by commercial mills; only a very small portion is ground by users in their own mills. In 1925 there were 32 commercial mills operated in 13 states, namely, California, Colorado, Connecticut, Illinois, Maine, Maryland, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, and Tennessee. These mills reported 212,300 short tons of ground feldspar sold, valued at $3,597,800, or $16.95 a ton, compared with 189,780 short tons, valued at $3,283,170, in 1924, an increase of 12 per cent in quantity and 10 per cent in value. Of this quantity 184,300 short tons, valued at $3,011,800, or $16.34 a ton, was domestic feldspar, and 28,000 tons, valued at $586,000, or $20.93 a ton, was Canadian feldspar. Canadian feldspar was ground in three states in 1925—New York, Ohio, and Pennsylvania. These figures represent increases in production and value of both domestic and Canadian feldspar as compared with 1924.

The production of crude feldspar by states in 1924 and 1925 is shown in the following table:

Crude Feldspar Sold By Producers in the United States in 1924 and 1925

State	1924 Long tons	1924 Value[b]	1925[a] Long tons	1925[a] Value[b]
Arizona	(c)	(c)	(c)	(c)
California	8,027	$ 62,344	6,000	$ 49,800
Colorado	(c)	(c)	(c)	(c)
Connecticut	6,572	51,422	10,300	71,200
Maine	29,912	271,354	28,400	256,700
Maryland	4,854	25,020	4,700	26,400
New Hampshire	39,425	324,638	38,300	278,700
New York	13,839	108,751	10,400	70,400
North Carolina	97,075	640,403	75,600	490,200
Pennsylvania	1,481	4,763	1,300	4,700
South Dakota	(c)	(c)	(c)	(c)
Virginia	(c)	(c)	(c)	(c)
Undistributed	3,587	20,644	9,100	58,200
	204,772	$1,509,339	184,100	$1,306,300

(a) Figures for 1925 are preliminary and subject to revision.
(b) Value at mine or nearest shipping point.
(c) Included under "Undistributed."

NEW INCORPORATIONS

Hackettstown Sand & Gravel Corp., Hackettstown, N. J. Incorporators: Clay M. Witaker, Hackettstown; Richard Townsend, Alvin Ohlsen, New York City.

Freeman-Loring Company, West Dennis, Mass. Dealers in construction and builders' supplies. Capital, $50,000. Incorporators: Arthur L. Loring, West Dennis; Frank H. Freeman, Harwickport, and Samuel D. Elmore, Brookline.

D. and G. Sand and Gravel Company, 127 Linden Street, Passaic, N. J. Capital stock, $100,000. Incorporators: Daniel Glerum, 127 Linden St., Passaic; Hawley Doty, 176 First St., Newark.

Mogadore Sand and Gravel Company, Canton, Ohio. Incorporators: C. A. Calhoun, John Coats, Walter McConnell, Wilber Coats and Dave Daugherty.

Cavanagh Concrete Materials Corp., New York City. Incorporators: M. and T. O. and C. M. Cavanagh.

International-Gypsum Co., Inc., Boston, Mass. Collecting and dealing in gypsum. Capital $300,000.

Price Stone Cement Co., New York City. Incorporators: E. and A. W. Price. Atty., W. P. Thomas, 645 E. Tremont Ave., New York.

Huntington Gravel & Supply Co., Huntington, W. Va. Capital, $100,000.

Superior Sand and Gravel Co., Detroit, Mich.

Glacial Sand & Gravel Company, Inc., Phillipsburg, N. J. Smith & Smith, Phillipsburg.

West Asheville Granite Stone & Sand Co., Asheville, N. C. Capital $100,000.

Loudon Sand & Gravel Co., Loudon, Tenn. Incorporators: S. P. Dannel, Sam P. Wilson, Don F. Smith, Joe H. Kollock and O. V. Harrison.

Atlantic Thermotite Company, Harrington, Del. Manufacture concrete materials. Incorporators: Loren B. Harrington, D. B. Thard, Warren H. Moore.

White Bridge Sand Company, Connellsville, Pa. Capital $40,000. E. S. Fairchild, 1207 Lang Ave.

NAST AND MUMM KILLED

Announcement of the death of George W. Nast, general manager of the Western Lime and Cement Company of Milwaukee will come as a shock to many of his friends in the industry. The superintendent of the company's plant at Brillion, F. W. Mumm, was in the automobile which was struck by a train causing the death of both men. Mr. Nast's connection with the lime and cement industry carries with it an interesting history since his grandfather first and then his father carried on the business which has grown to such large proportions.

A NEW PUMPING OUTFIT

A new pumping outfit—developed by Novo the first of this year—is shown at work in the accompanying illustration. That it handles a large volume of water is proved by this picture. Novo rating of this pump, always conservative, is 16,000 to 20,000 gallons per hour. Total head 20 feet. Closed top forces diaphragm pump (double) similar to the double open top diaphrahm pump shown has the same capacity. The total head at which the closed top pump will operate, is 50 feet. This makes it possible to lift the water to a distance of 30 feet above the pump, allowing the usual 20 feet for suction lift. While the pumps themselves are similar to those built by Novo for several years, it is the power unit, speed reducing unit and live rubber diaphrahms that make the outfit unusual.

The power unit is the type, 3-6 HP two cylinders, Timken tapered roller bearing engine. This engine, also brought out the first of the year, is proving to be one of the most successful engines developed by Novo in the past eighteen years of building engines and industrial construction equipment. Utilizing an opposed throw counterbalanced crankshaft, the drive shaft (gear driven from crankshaft through power gears) and the crankshaft run in Timken tapered roller bearings. This engine operates without vibration under all load conditions and with minimum power loss.

To reduce the engine speed, to a show reciprocating motion, an enclosed speed reducing unit, with crank arm is employed. This unit, designed for use with the Novo UF engine, is enclosed and dirt proof. Gears run in a bath of oil. Babbitted adjustable bearings are used. Drive shaft pinion and speed reducer gear also run in oil and are enclosed in a gear case. The outfit runs quietly; all parts, with adequate protection and lubrication, have long life.

The properly designed, live rubber diaphrahms with which this and other Novo diaphragm pumps are equipped, operate, under normal conditions, from one hundred fifty to two hundred hours. This feature, as well as others enumerated above, is appreciated by users. Time is an important factor. The Novo diaphragm pump shown in the accompanying illustration is owned by the B. & B. Construction Co., Sarasota, Florida.

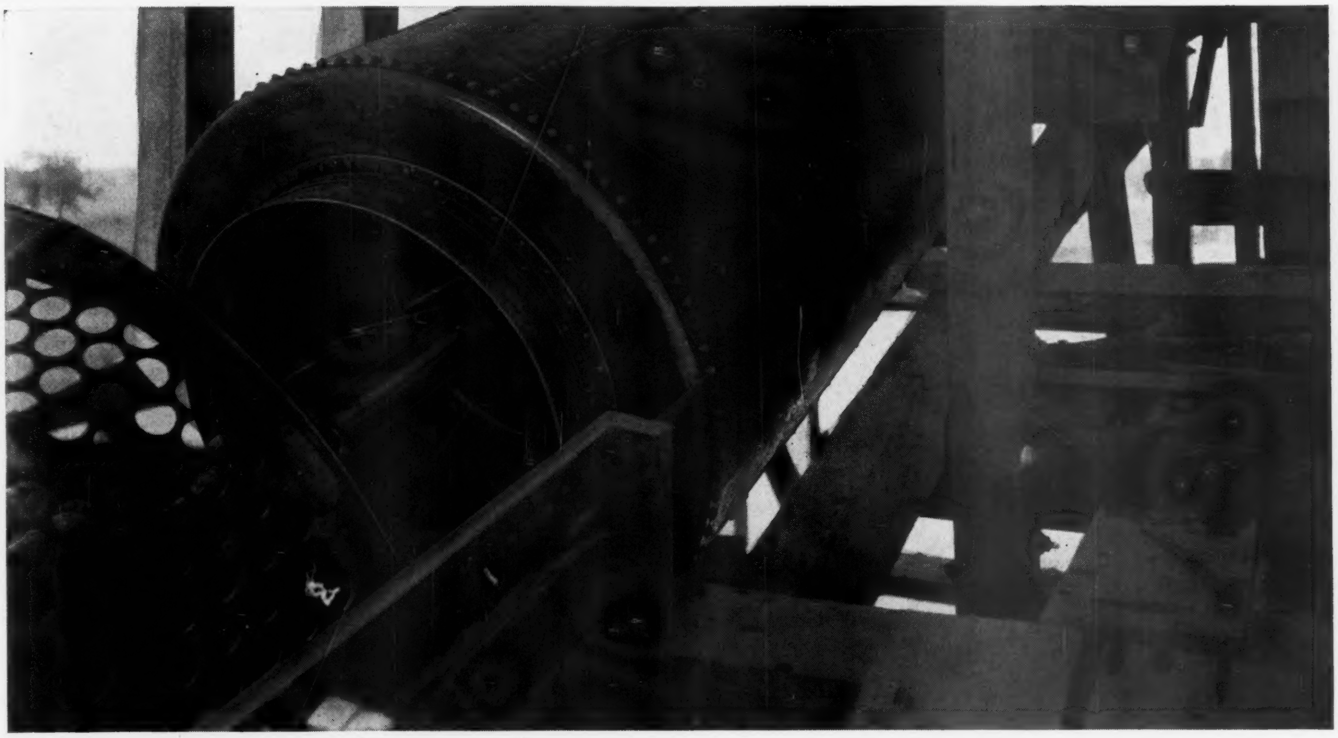
ALLOY CAST STEEL

The Alloy Cast Steel Company, Marion, Ohio, has recently been organized by H. J. Barnhart, Frank D. Glosser, Walter A. Dorsey, and E. J. Schoenlaub, all of Marion, Ohio.

The Company has purchased the electric steel foundry of the Fairbanks Steam Shovel Company which was recently sold at receivers sale. The plant is now being completely overhauled and enlarged to a capacity of 400 tons of steel castings per month. Extensive additions of modern foundry equipment will be installed at once. The new company will manufacture high grade electric steel castings in carbon, manganese and other alloy steel.

The new owners have had considerable past experience in the manufacture of steel castings and have already perfected an operating organization capable of making high grade steel castings and giving prompt and satisfactory service.

The New Novo Pumping Outfit



Scrubbing Before Screening

MANY gravel deposits have clay and other impurities of such nature and quantity as to require some preliminary washing treatment, to put the material into proper condition for quick and effective preparation by the screens. This washing previous to screening is termed scrubbing.

We are successful in dealing with materials which others give up as impractical of economical handling. In other instances we accomplish with short conical screens, in combination with a suitable system of scrubbing, what otherwise could not be done except with equipment of far higher cost and possibly much lower efficiency.

The Preliminary Scrubber is a solid cylindrical shell, with internal retaining rings dividing the length into compartments, which retard the progress of the material through the Scrubber while lifting vanes raise and drop the material into a bath of water.

By the washing and scouring action of the repeated lifting and dropping, the lumps are reduced and the impurities well separated, so that the material may pass to the screens, in proper condition for sizing and rinsing.

This type of scrubber is mounted on a center shaft which is coupled directly to the screen shaft, forming a continuous shaft. The usual driving gears are then placed on the scrubber shaft to drive the entire set.

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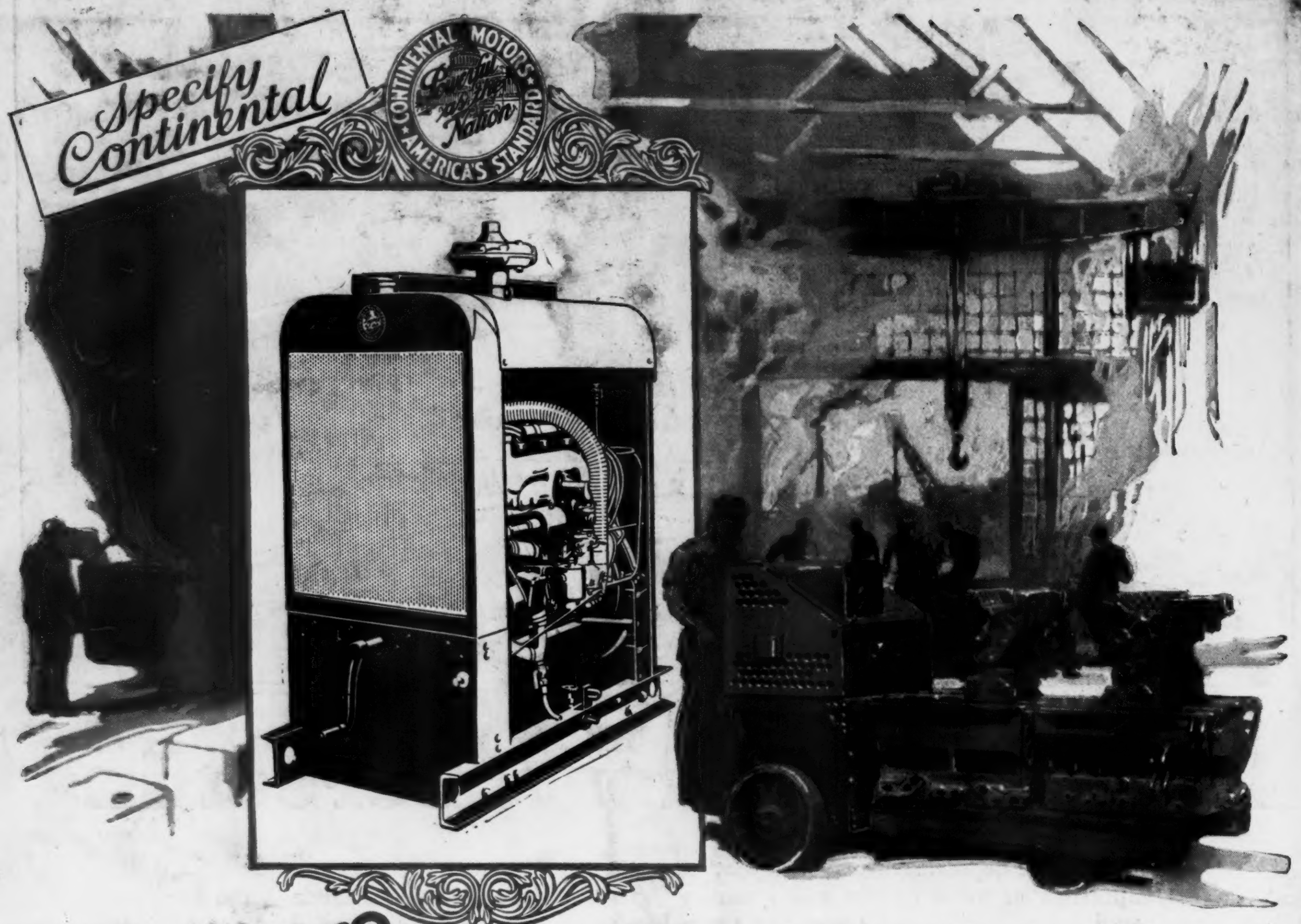
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